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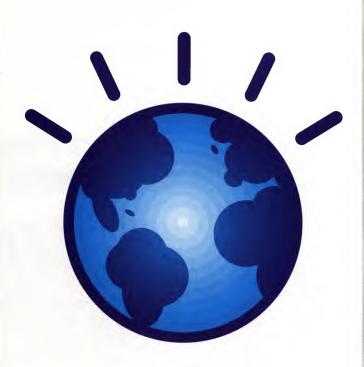
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# GOOD NEWS. YOU'VE BEEN RGRADEL

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# Welcome to the decade of smart.

A year ago, we began a global conversation about how our planet is becoming smarter.

We talked about intelligence being infused into the systems and processes that make the world work—into things no one would recognize as computers: cars, appliances, roadways, power grids, dothes, even natural systems such as agriculture and waterways.

We said that trillions of digital devices, connected through the Internet, were producing a vast ocean of data. And all of that information—from the flow of markets to the pulse of societies—could be turned into knowledge because we had the computational power and advanced analytics to make sense of it all.

A year into this new era, the signs of a smarter planet are all around us. Smarter systems are being implemented and are creating value in every major industry and across every region of both the developed and developing worlds.

This idea isn't a metaphor, or a vision, or a proposal—it's a rapidly emerging reality.

In a study of 439 cities, those with transportation congestion systems showed an average reduction in travel delays of more than 700,000 hours annually.

A yearlong study by the U.S. Department of Energy's Pacific Northwest National Laboratory found that consumers within smart meter systems saved 10% on their power bills and cut their power usage by 15% during peak hours.

Eight hospitals and 470 primary care clinics were able to improve clinical results and operational efficiency by up to 10% through information access at the point of care.

Leading retailers have reduced supply chain costs by up to 30% and increased sales by up to 10%—through analyzing buying behaviors, aligning merchandising with demand and building end-to-end visibility from manufacture to sale.

Everywhere, forward-thinking leaders are achieving near-term ROI. But they are also discovering something deeper. They are finding the hidden treasures buried in their data.

Data is being captured today as never before. It's revealing everything from large and systemic patterns—of global markets, workflows, national infrastructures and natural systems—to the location, temperature, security and condition of every item in a global supply chain.

Then there's the growing torrent of information from billions of individuals using social media. They are customers, citizens, students and patients. They are telling us what they think, what they like and want, and what they're witnessing. In real time.

That's a lot of data, but data by itself isn't useful. In fact, it can be overwhelming—unless you can extract value from it. And now we can. With the right tools, we are beginning to see patterns, correlations and outliers.

With sophisticated mathematical models, we can take the measure of the world's information and actually begin to predict and react to changes in our systems. New York has smart crime fighting. Paris has smart healthcare. Galway has smart water. A smart grid in Copenhagen keeps energy flowing.

We've learned a lot over the past year about what it takes to build a smarter planet—and about the issues it raises. Issues like protecting personal information and securing critical infrastructures. We've learned that we will need global standards across all dimensions of these complex systems. New skills and fields of expertise. New ways of working and thinking. A smarter planet also requires a profound shift in management and governance.

Business leaders, policymakers and government officials around the world understand these challenges, and are stepping up to them. Above all, they realize that we cannot wait, cannot let this moment pass. The time to act is now. And the way to act is together. The decade of smart is under way.

Let's build a smarter planet. Join us and see what others are doing at ibm.com/smarterplanet















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BY JORDAN

BY JORDAN

ELLENBERG

Artifacts from the future.

# On the Cover

Photographed for WIRED by Zachary Zavislak. Sculpture by Stephen Doyle.

# Sprint brings you the best lineup of phones plus the 3G network PC World named

most reliable. Take your pick from a pint-size multitasker, an apps-ready Android"-powered device and the new BlackBerry® Curve, a smarter smartphone. They're all here. Welcome to the Now Network.™ Bringing you the first and only wireless 4G network from a national carrier, 1-800-SPRINT-1 sprint.com/bestphones



Sprint tested as the most reliable 3G network in comparison to AT&T and Verizon in a 13-city 3G performance test conducted by PC World.

operating platforms available combined with capabilities of devices. PC World Claims lies indicated 13 chies with more than 20 tests per city from March to April 2009 in all, 5,443 individual tests from 283 testing incolores were conducted. rowder's netromade 3G service Testing was one minute in duration, and network performance can be highly variable by location. Other included Baltimore, Boston, Chicago, Deniet, New Orleans, New York, Orlands, Princers. Portland, Sim Diego, Sum Jose, Sun Franceco and Seatler for metabolistic Sprint wom in Bodom, Chroago, Demier, Portland, Sim Diego, Sim Franceco and Seatler and Bed in Orbado 46; 46 is currently available in limited areas and on selec-plane and devices, check sprint com 4G for Sprint 4G coverage/device info. Palm Plaic Use of this device also requires a Palm account, activation and acceptance of Palm terms. BlackSerry; Access to corporate area! They require StackSerry. Emargines Server (BES) access: Other Terms: Coverage not available everywhere. The Nationwide Sprint Network reaches over 275 million people. The 3G Sprint Mobile Broatband Network reaches, over 253 million people. Others not available in all markets/retail locations or for all phones/retaivorks. Other restrictions author See store or

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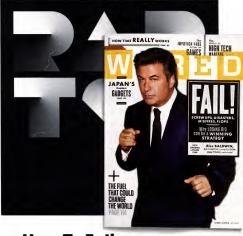


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# YOUR 15 MINUTES

Dear fame-seekers, Want to get on the cover of whee ? To see if you have what it takes, consult the handy diagram below You'll notice that past cover subjects had certain things in common.



# RE: How To Fail

Our January cover guy was Alec Baldwin, and fanboys just couldn't get enough. On the wireto Web site, the comments quickly devolved into a Baldwin lovefest, as readers debated his best roles (The Shadow? Thomas the Tank Engine and Friends? SNL host with the most?). Even contributing editor. Scott Brown was a little swoony: He told us that Baldwin was "100 percent full of himself in the most good-natured way. He makes you want to be full of him, too." Hey, no need to convince us. We think TiVo was invented solely to allow us to play classic Jack Donaghy moments again and again.

EDITORIAL CORRESPONDENCE rants@wired.com

# **Great Mistakes**

Because I recently lost a high school election. I found "How to Fail" (issue 18.01) particularly poignant. Yet there was one gaping omission from your list of brilliant losers: Al Gore, After the 2000 election, Gore was able to reinvent himself. He is now the world's foremost advocate working to combat climate change. earning an Academy Award, the Nobel Peace Prize, and even a Webby for his work. This is the Rocky story of the decade! If anyone deserved a nod in your article, it was Mr. Gore.

Noam Freshman St. Louis Park, Minnesota "The Neuroscience of Screwing Up" (Issue 18.01) draws the conclusion that "the only scientiate capable of acknowledging the anomalies and thus shifting paradigms ... are either very young or very new to the field." The Easturn philosophers have known this for centuries. They refer to it as "beginner's mind."

Steve Zimmerman Scottsdale, Arizona Experiments are never "failures." Even my third-grade students know to go where the data takes you, whether it confirms your hypothesis or not. An unexpected result, if it's repeatable, attill leads to a declaive conclusion until succeding tests prove it wrong. George Orwell said, "To see what isn in front of one's nose needs a constant struggle." Even for some scientiste, apparently.

Ron Tyler Calgary, Alberta

This issue fails. Eric Seven Phoenix, Arizona

# Senior Reader

JEIIIUI REGUE!

Wy late mother—in-law's mail is now being forwarded to us, and now being forwarded to us, and now being forwarded to us, and now being the late of the late of

# "THANKS FOR THE DETAIL ON SHOE Polish. I can finally say with confidence I know shit from Shinola."

Excerpted from a comment posted on Wired.com by DERRICO

EDITORIAL CORRESPONDENCE rants@wired.com



# OUR 15 MINUTES



We're print people first and get our hands on an iPadbut once in a while our black-and-white words end up on the silver screen. We're looking forward to watching talhotblond, a documentary about an Internet identity hoax that led to murder. Nadva Labi first told the tale in our Sep ber 2007 issue ("Flirting With Disaster"), and now the movie is available on Tunes and due out on DVD in March. It's the first win niece in recent memory to become a film, but it may not be the last: Two stories by contributing editor Joshua Davis are currently in screenwriters' hands "Sea Cowboys" (Issue 16.03) is being developed by Dreamworks, and none other than J.J. Abrams is producing the movie version of "The Untold Story of the World's Biggest Diamond Heist" (17.04) for a Soviet weapon, "The Doomsday Machine," by senior editor Nichola ionment as well Have your people call our people



# Game Over

I've worked in the game industry for more than 15 years, and lived the Duke Nukem asage ("How Success Killed Guke Nukem." issue 18.01), i marveled at the original games of design and waited for the sequel that never came. High-profile games are much like big-budget movies now. The first title i worked on cost \$1.5 million, my most recent more than \$17 million. When the cost and stakes are this high, feliure is not an option.

Eric Adams Los Angeles, California

I can't be the only reader who found inadvertent humor in the acronym for *Duke Nukem Forever*. In the race-running world, DNF stands for "did not finish." Stephanie Murdock San Diego, California

# Cultural Exchange

I am confused by the East-vs.-West competition in Test (Issue 18.01). A Canon camcorder appears under the "USA" heading, but Canon is a Japanese company.

Steve Crowley Washington, DC

Yes, Canon headquarters is in Japan. But our story was about how companies ship different products to different markets, hence the placement of the camcorder in the USA column.

# **Hire Education**



Emery Soos Pickering, Dotario



Why don't you present the other side of the equation-how such options give people the ability to do what they are qualified to do, even if life circumstances prevent them from getting "official" pieces of paper? What if you tested the "fake" people egainst the "real" people? I bet the yuppie babies out of college would do e lot worse than the people who technically cheated but wanted the job desperately and really read up end studied on their own to get it. A "diploma mili" is a social equalizer

Excerpted from a comment posted on Wired.com by GREENGESTALT

A real diploma is, among other things, proof that you can persevere and finish a long-term project. Calling a diploma mill a "social equelizer" is like justifying theft as "weelth redistribution."

Excerpted from a comment posted to Wired.com by GATEKEEPER2000



# Time Trouble

Who doesn't love a good physics debate? After reading our plece on physicist Sean Carroll's new theory of time ("The Chronologist," Print, issue 18.01), these two readers went at it in the Comments section:

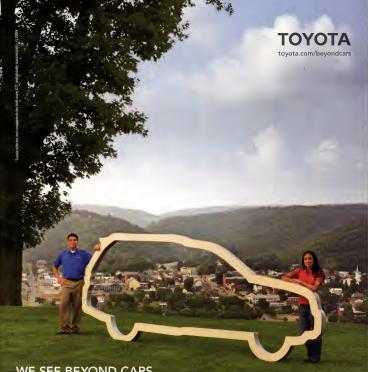
SIXWINGS: This guy knows as much about time as my dog. Time cannot flow or change, by definition. It's an abstract concept.

CLARPET: @akwings: Your dog should retake Physics 101. Then he'd understand that the approach here is to explain how the perception of time relates directly to the way it is observed and/or experienced, end that the suggestion is that time is observed, and therefore perceived differently under different circumstances. See: Schrödinger's cat.

SIXWINGS: @Clarpet: You should take Logic 101 since time is neither experienced nor observed.

# UNDOS

Individual states, not accrediting agencies, give aducational institutions the authority to grant degrees ("Summa Cum Fraud," issue 18.01). Photo labels for the movies *Dragonquest* and *Mega Shark vs. Glant Dctopus* were switched in "Attack of the Clones" (Issue 18.01).



# WE SEE BEYOND CARS.

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> Pictured: Antonio Spagnoli & Janai Grayson, Toyota Team Members Toyota Highlander, built in Princeton, Indiana\*

FROM THE PRODUCERS OF PLANET EARTH

SUNDAY, MARCH 21, 8PM

Discovery



DISCOVERY.COM/LIFE ELEVEN EPISODES NARRATED BY OPRAH WINFREY.

DRIVEN BY DISTRACTION

How Twitter and
Facebook make us more
productive workers.

BY BRENDAN I. KOERNER

our random tweets about Android apps and last night's Glee are stifling the economic recovery. At least, that's the buzz among efficiency mavens, who seem to spend all their time adding up microblogging's fiscal toll. Last year, Nucleus Research warned that Facebook shaves 1.5 percent off total office productivity; a Morse survey estimated that on-the-job social networking costs British companies \$2.2 billion a year.

But for knowledge workers charged with transforming ideas into products -whether gadgets, code, or even WIRED articlesgoofing off isn't the enemy. In fact, regularly stepping back from the project at hand can be essential to success. And social networks

ILLUSTRATION BY Markus Hofko

Studies that accuse social networks of reducing productivity assume that time spent microblogging is time strictly wasted. But that betrays an ignorance of the creative process. Humans weren't designed to maintain a constant focus on assigned tasks. We need periodic breaks

to relieve our conscious Tweets about minds of the pressure to perform—pressure that Lady Gaga's lingerie can be an can lock us into a single enormous help to mode of thinking, Musing someone debugabout something else for a while can clear away the ging Perl code. mental detritus, letting us see an issue through fresh eyes, a process that

creativity researchers call incubation. "People are more successful if we force them to move away from a problem or distract them temporarily," observe the authors of Creativity and the Mind, a landmark text in the psychology and neuroscience of creativity. They found that regular breaks enhance problem-solving skills significantly, in part by making it easier for workers to sift through their memories in search of relevant clues.

That doesn't mean that employees should feel free to play Minesweeper at will, however. According to Don Ambrose, a Rider University professor who studies creative intelligence, incubation is most effective when it involves exposing the mind to entirely novel information rather than just relieving mental pressure. This encourages creative association, the mashing together of seemingly unrelated concepts-a key step in the creative process.

History is full of tales of revelations that were helped along by such conceptual collisions. Alastair Pilkington came up with the idea for float glass, the inexpensive successor to plate glass, while washing dishes; the grease that pooled atop the water inspired him to pour molten glass onto melted tin, resulting in a perfectly smooth pane. And George de Mestral had the initial brainstorm for Velcro during a 1941 hunting trip. when he noticed how difficult it was to pick Alpine burrs off of his clothes.

This means that tweets about Lady Gaga's lingerie can help someone debugging Perl code. (Or a tweet about Perl code may help Lady Gaga's under-

wear stylist.) A random scrap of information can trigger just the right conceptual collision. It's hard to know which scrap might do the trick, but that's the beauty of social networks-they constantly produce potential sparks, for free.

The participatory nature of Twitter and Facebook also makes them excellent tools for supercharging creativity. Users finely craft their bons mots to grab people's attention and perhaps earn a retweet or two.

As football coaches have long preached, you should practice like you play. Twitter and Facebook give knowledge workers

the chance to turn downtime into a game where creativity and insight are rewarded. if only with digital pats on the back. Formulating a clever tweet about the lat-



Ah, right-it was @THE\_REAL \_SHAQ. Hmm, wonder what he's tweeting right now? Let me check. W

Contributing editor BRENDAN I. KOERNER (brendan koerner@wired .com) is wired's Mr. Know-It-All.

# BES' Unbuilt Thrill Rides

# SS Disney

A former shipbuilder devised this floating theme park. A Disney-fied supertanker was to dock in ports worldwide, spreading the gospel of Space Mountain and-ugh!-It's a Small World to potential Mouseketeers everywhere,

#### Stratosfear

The ride promised to plunge passengers 700 feet down the side of the Stratosphere hotel in Las Vegas (at 120 mph). It would have been the tallest coaster in the world.

#### Cantilevered Coaster

This one flings you off the tracks-on purpose. The passenger compartment is separated from the wheels by a support arm, and the upper portion of the split-level track drops away sometimes, giving riders the illusion of being airborne. One projected use: a re-creation of the car chase in Bullitt.

## Hurricane Simu

In the 1970s, some Miami folks had the bright idea to make a 150-foot-long wind tunnel and invite the public in. It fell through. but thrill-seekers take heart-Florida continues to be buffeted by actual hurricanes.

## The Inverter

Racing around on top of the tracks is for suckers. In this concept from Gordon Rides. trains run underneath a track-a wooden one. The rickety feel of century-old coasters meets the foot-dangling precariousness of inverted coasters. What's not to love?

# **Eiffel Tower of Terror**

This ludicrous idea, sketched in 1891, involved a 10-ton "bullet" that could hold 20 people. The cansule would be drooped from the belly of the Eiffel Tower into a huge pool of water shaped like a wine glass. Sacré merde. that sounds dangerous. - Cameron Bird

# DATASTREAM CAMOUFLAGE PATTERNS OF THE WORLD

























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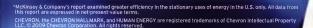
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# MINISTER OF TRUTH

# The UK's data cop protects the public from lies, damn lies, and statistics.

Did you know that 82 percent of all lotted statistics are hopus? Dik, we made that up. But after a 2007 poll found that barely at hird of all British lictures trust published stats, Parliament formed a math-police squast to investigate. The top cop in the UK Statistics Authority is Richard Alldrift, an expert in how governments fuggle the number 9. Alldrift began his carear analyzing crime data at the Home Office in London. "I got hooked on what you might call the politics of statistics," he says. Now, a head of seasement, his monitor in figures from rouphly 200 public agencies. He opens the district of the properties of the properties of the specific of the statistics of the properties of the specific of the



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to write a cyberpunk detective novel or record synth covers of Miles Davis tracks. You could dip into your life savings to fund the project. Or you could hit up Kickstarter a new crowdsourced fundraising service Each project gets a dedicated page showing the pitch, a financial goal, a deadline and a list of rewards that backers will receive (say, a copy of the finished work. some unique service, or just heartfelt gratitude). If the fund-raising goal is met in time. the money-minus Kickstarter's 5 percent cut-goes to the creator. If it isn't, the donations are refunded. Some projects that have exceeded their funding goals: a highbrow videogame magazine, a documentary about Calvin and Hobbes. and an "Erector set for the Internet age." With most donations at \$50 and under Kickstarter is kicking

off a wave of

impulse patronage.

Windows. Life without walls. Toshiba recommends Windows 7

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# Nukes Yeast, Zaps Static

Dandruff is caused by a yeast infection. Yeast eat your scalp secretions and metabolize them into olelc acid. Dleic acid in turn irritates your skin, which sparks an increase in cell production. and thus an increase in dead skin cells (though only if you are predisposed to dandruff-some people don't react to oleic acid), Pyrithione zinc depolarizes yeast cell membranes, which kills them.

# NIIIM-10

For something with a name like a sci-fi planet, this ingredient is pretty humdrum, It's a moisturizer (it helps provide the "dry scalp care") and an antistatic egent (now that your pate is free of dead skin, you don't need to look like a live wire).

There is natural oil

A mineral formerly called calamine and now called smithsonite (after the man whose money was used to found the Smithsonian), this astringent was used in the old days to dry up skin lesions. Here, it ensures that the zinc and pyrithione stay mixed together and effective.

# SODIUM LAURETH

A detergent and foaming agent common in shampoos. The detergent lifts grease and dirt off your scelp and hair, but the foam is cosmeticpeople just like foamy cleansers

# IMPTHICANI

on your hair, and when you wash it all away, your follicles are clean, dry ... and unprotected. Dimethicone is a silicone-based oil -you might know it as the squishy stuff inside breast implants-that conditions and protects the hair until its natural oils build up again.

This waxy substance adds a milky pearlescent quality to the shampoo, It does hair, but it is osvchologically vital: According to Head & Shouldere maker Procter & Gamble. are perceived by the

# WHAT'S INSIDE HEAD & SHOULDERS\*

P&G tells us that these are excipients, substances that help the active ingredient, pyrlthione zinc, work more effectively. In this instance, the excipients probably keep the pyrithione zinc well suspended In the solution and encourage it to home in on your scalp.

These two preser-

vatives kill any becteria that form in the bottle. In a test tube, methylisothiazolinone (MIT) has been proven to kill neurons, but don't worry: Even the European Union, which is generally 4 much stricter than the FDA, agrees that MIT is safe in shampoo. So that should be a weight off your shoulders. -PATRICK DLJUSTO







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THE BLOODY TRUTH
What evidence tells us when it drips down the wall.

Some people can't stand the sight of blood. Rod Englert is not one of those people. A detective with 45 years of investigative experience, Englert analyzes the Jackson Pollock-like spatters of hemoglobin and plasma at crime scenes. His new book, Blood Secrets, touts his biggest cases, and it's also a handy manual for wannabe Dexters (minus the serial killing, we hope). Here's a look at what those stains are trying to tell you.—KATIE BAKER

1. Angular
If the victim was
on the move,
drops hit at
an angle. The
more oblique
the impact,
the longer the
drop's tail. The
head points in
the direction
the person was

Velocity Misty, diffuse spatter is created by external force greater than 100 feet per second—which usually means a gunshot, an explosion, or (seriously) a

2. High

sneeze.

3. Hair Impact
A traumatic
impact between
head and surface tends to
leave a stain
with feathered edges,
like someone
squished a
loaded paintbrush against

the wall.

4. Hair Swipe
If the smear
fades out in
one direction,
the head was
likely bloody
before contact.
The lightest
edge of the
swipe points in
the direction
the head was
traveling.

5. Fabric Swipe More fluid than hair swipes, these stains sometimes display the imprint of the bloodied clothing. T-shirt weaves are often the easiest patterns to decipher.

# Jargon Watch

#### Raptorex

n. The flyweight evolutionary predecessor to T. rex, which it resembled—at about a hundredth the size. The raptorex terrorized inner China 60 million years before the 6-ton T. rex tore up North America.

### English shellcode

n. Melware embedded in ordinary English sentences. By making the code resemble email and wikipedia entries, Johns Hopkins researchers have revealed a new way that hackers might dodge antivirus software and hijack

# Quantum

trampoline
n. An instrument that
measures gravity by
using laser pulses to

measures gravity by using laser pulses to repeatedly bounce chilled atoms. Once it's out of the lab, the new device could aid in oil prospecting.

## Mandelbulb n. A threedimensional fractal.

While mathematician Benoit Mandelbrot's famous set 
has been used to 
create trippy 2-0 
images since 1975, 
the 3-0 Mendelbulbs had to await 
the genius of frectal 
artist Daniel White, 
whose computer 
renderings resemble 
orchids on acid. 
—Jonathow ired. com 
[urgan@wired.com]



# ADD AS IRITAD

Day in and day out, we have a weapon in our hands. Very powerful. A weapon of mass construction - the Internet. The largest meeting place ever known, where communication and interaction reign and proliferate. The most effective antidote to war and hatred has always been the meeting of minds and souls. Just a few reasons why the Internet deserves the next Nobel Peace Prize.

A Nobel that will be awarded to each one of us.

A Nobel that with be awarded to each one or a

Join us on: (www.internetforpeace.org)

# DEAR MR. KNOW-IT-ALL

I'm always hearing that space is crowded with man-made debris. What's the chance of a collision knocking out my beloved DirecTV?





WEALFREAKED OUT ailtitle last February when a couple of satellites T-boned each other in the skies over Siberla. But it's highly unlikely that a similar smashup will ever mar one of your Syfy marathons. The satellites involved in last year's collision were circling at relatively low altitude—just 490 miles above Earth's surface. Direct'V's satellites, by contrast, are in geostationary orbit 22,300 miles over our heads. The space-junk problemis less acute up vonder.

On the (extremely) off chance that one of DirecTV's satellites is accidentally demolished, however, your pain should be minimal. "Customers might experience a brief disruption of service if we had to reposition the fleet," says Robert Mercer, a DirecTV spokesperson. Yes, that would still blow if if happened during the final segment of Starspate, But as the Buddha once observed, life is suffering. Crack a brow and deal.

I recently had a testy exchange with a traffic cop, who claimed I blew through a stop sign in a school zone. When I began recording our contretemps, he threatened to arrest me. Don't I have the legal right to document such interactions?

# All in good toste.



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Smoking our "light mellow taste" or "ultra light mellow taste" filtered cigarettes does not reduce or elliminate the health risks of smoking. Natural American Spirit® is a registered frademark of Santa Fe Natural Tobacco Co. © SFNTC 1 ▶Though the laws of this great land generally favor Smokeys over Bandits, this is one instance in which (alleged) scofflaws like you are probably in the clear. But the final verdict will depend on where, exactly, you do your motoring.

See, the rules that govern audio and video recording vary from state to state. Thirty-eight states and the District of Columbia require only one-party consent, which means you're free to stick your iPhone in any conversation partner's faceeven if they wear a badge. But a dozen states mandate that everyone who's chatting must agree to be recorded. (A full list of state taping laws is available on the Web site of the Reporters Committee for Freedom of the Press,)

But don't give up hope if you live in one of the holdouts, Bandit, Keep in mind that the cop may well be taping you with a camera mounted on his cruiser's dashboard. "That

at least implies permission for the person stopped to do the same," says Robert C. Power, a professor at the Widener University School of Law. So feel free to ask the cop if he's capturing your exchange

for posterity; if he is, you can credibly claim a right to do likewise.

Of course, Smokey may not care for your highfalutin' legalese and could easily decide to slap on the cuffs and let the courts sort it out. So before you push the issue too far, ask yourself this: Just how badly do you want to be the Rosa Parks of iPhone recording?

An ex-colleague recently asked me for a LinkedIn recommendation. Am I obligated to comply? The only thing I can remember about the guy is that his shirts were always so neatly pressed.

This may be tough to fathom, but social-network requests are actually much less binding than, say, the dinner invitations of 18th-century Russian czars. The easiest way out of this dilemma is simply to ignore the fellow's appeal-and rest assured, the vast gift economy of the social-networking universe will keep on chugging along.

But there are consequences to that approach-namely, that you can kiss this tenuous relationship good-bye forever. That may seem trivial right now, but you never know where Mr. Former Coworker might land. As Sigourney Weaver so eloquently put it in the 1988 cinematic masterpiece Working Girl, "Today's junior prick, tomorrow's senior partner." And, besides, you're a fan of the Golden Rule, are you not?

None of this means you need to fib on your recommendation. If you really can't recall anything about

> the bloke save his sartorial tidiness shoot him a Linked-In message and tactfully ask for a refresher course in his awesomeness. "There's nothing wrong with going back to the asker and

saving, 'Hey, it's been a while-can you remind me what your strengths are?" says Kirsten Dixson, author of Career Distinction: Stand Out by Building Your Brand, "Have him give you some bullet points to work with."

Of course, his reply still may not ring any bells, in which case you should feel free to write a brief report extolling his ironing skills. If his feelings are hurt by such faint praise, so be it. That's the risk one takes when desperately trolling Web 2.0 for random kudos W

Need help navigating life in the 21st century? Email us at mrknowitall@wired.com.

# STATGEIST // CHARTING THE WIRED WORLD

# Uses for a 3-D TV



- Watching Avata repeatedly
- Porn Proving you once had \$10K
- Triggering migraines Avoiding life which feature which features actual 3-D

# The human "nmes"



- Genome ■ Proteome
- Metabolome ■ Neurome
- Metagenome

# What's on the iPad



- Grainy video, but bigger
- Stuff your Palm Pilot dld
- Stuff your iPhone
- Desperate attempts to save
- Apps for tweeting while pooping

# Time spent at an airport



- Disrobing for security
- Recovering from security
- Hunting for power outlets Wilsons Leather
- Warily eyeing people with di skin, beards

Finessed and furious.

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# In-Flight Science

NASA's new jumbo jet keeps one giant eve on the heavens.

It's just your typical little research project: a Boeing 747 with a 17-ton infrared telescope in back, searching for newborn gal-

axies and signs of extraterrestrial organic matter. After three years of testing, the Stratospheric Observatory for Infrared Astronomy will finally start collecting data this

spring, making it the world's biggest airborne telescope. The plane's 45,000-foot cruising altitude puts it 10.000 feet higher than most commercial flights and above 99 percent of the water vapor that obscures the views of ground-based scopes. And a precisely plotted curving flight plan helps the telescope stay focused on a single target, with software telling the 747's autopilot what to



# PLUG AND PLAY USB albums we'd like to see.

The CD is dead. Long live USB drives. The Pixies are releasing tracks on USB-drive wristhands. The Get Busy Committee dropped an Uzi-shaped USB album. The Beatles' recent box set came out on a 16-GB drive shaped like an apple. So who'll be the next act to jump on the USBandwagon? -- David Downs



# A USB cassette tape. Lo-fi retro indie pop is

better with the latest hi-fi lossless encoding.



# Spoon

A USB spork, Precision cuts from a tool with no knife. Get it? Oh man. we're so over your head.



# Amy Winehouse A USBeehive, Troubled singer bounces back

with album shaped like her hairdo. Buzzworthy!



# Arcade Fire A USB drive shaped

like the handlebars of a fixed-gear bike. Easy to peddle to hinsters



# RAPTURE, REIMAGINED

A few years after its predecessor Bioshock, snagged a flotilla of awards, Bioshock 2 is aweing reviewers once again with its innovation, narrative game play, and stunning visual effects. The game that takes the first-person shooter genre to the realm of epic badassery, Bioshock 2 unleashes a flood of compelling animation, storylines and calculated mayhem that will challenge both the intellect and skill of any player brave enough to dive in. We wanted all the glorious and gory insider details, and were lucky enough to score some Q&A time with Jordan Thomas, Creative Director of Bioshock 2 »»»

What would you say is the most striking feature of Bioshock 2? We really focus on the narrative again. and the philosophical underpinnings of the setting. In the first game the underwater city, Rapture, was in the midst of a genetic civil war, and in Biosbock 2 the setting is ten years later: Rapture has fallen into moral and physical decay, and the villain responsible has wrought a sort of mandatory altruistic collective enforced by an army of mutants. The player - the protagonist - however, refuses to join in the dystopian dream, and instead embarks on a mission to subvert the controlling ideology and free Rapture. Is the game a sart of marality play, then? Well, it's hard not to acknowledge a little bit of a contemporary political parallel, but really because the game can unfold in any number of ways based on player input, it's less a morality play and more an ethical interrogation the player can be entertained by as well as perhaps be provoked into some personal insight by. The choices around alliances and family contribute to developing strategy as well as evolving the plot, and outcomes are variable We've really gotten past the formulaic; in a way, the game exists to ask interesting questions, and certainly doesn't pull any punches. Is it a standalone game or pure sequel? It stands on its own, certainly, but fans of the first Biosbock will appreciate the trajectory of the narrative - for example, the POV reversal with the new protagonist. There are known and new weapons that allow both more flexibility and capability, and the new AI is actually aware of the environment, so objects behave appropriately to stimuli and emergent situations, sometimes startlingly so. The multiplayer modeispretty much straight-up craziness, though, right? Chaos is definitely more intrinsic - multiyer is actually set in a different time, before the fall of Rapture, and players take the role of citizens competing for resources in an aggressive, Darwinian oath. And the fun and intrigue of earning new weapons, plasmids and so on increases the odds that players will generally be wreaking havoc with them. But the one element of stability is character development: no matter what mode a player is in or who they are playing with, their character's attributes remain constant, so the experience points and everything else are continually refined throughout game play, giving the player a real sense of identity. We can't wrap this upwithouthearingabouttheamazingimageryand physics. Yeah. We did tons of research to create this visual pastiche of Jules Verne idealism and authentic Art Deco skyscrapers and all the insistent! neon! advertising! of the free market period, neatly balancing the squalid and the tawdry. And because it's deteriorating at the bottom of the Atlantic, suddenly a space will fill up with water and we really had to tinker with the physics middleware so that everything (including "rag dolls" - i.e. bodies) in that space would behave naturally according to the laws of submersion, Even subtle things, like the near-imperceptible drift along the ocean floor... we fussed with it a lot.

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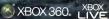


The undersea city of Rapture stands in ruin. Somewhere deep within, your Little Sister awaits. Once you protected her and now, amongst hordes of genetically-altered maniacs, she is your only hope for salvation.











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Games for Windows



# How to...



# **Nail a Free Throw**

Sinking a foul shot doesn't just happen—there's a method to the March madenss. Larry Silverberg and Chau Tran, two engineers from North Carolina State University, ran more than 100,000 3-D simulations of free throws to determine the perfect trajectory. Here's their strategy for scoring like a champ from the charity stripe. —Cameron Bird

# 1. Think deep

Don't focus on just clearing the lip of the hoop. Aim about four inches past the center of it so the ball ends up a couple of inches from the back of the rim.

# 2. Get high

Shooting from a low position will make you chuck the ball, increasing potential for error. Release the ball as far from the ground as you comfortably can.

#### Rainbow it You want a gentle

arc, launched at a about a 50-degree angle. At the peak of its trajectory, the ball should be about 2 inches below the top of the backboard.

# 4. Control

Backspin is your friend. To deaden the rock on impact, go for about three full revolutions.



# TURN AN FM TRANSMITTER INTO A MICRO PIRATE RADIO

Corporate radio is preprogrammed iunk. But don't curse the D.I seize the airwaves! With a soldering iron and a cheapo FM transmitter-the kind used to play an iPod through a car radio-vou can transform your humble Honda into a Radio Free Civic that can broadcast your tunes up to 100 feet. -MATHEW HONAN

#### 1. Pry open the transmitter's case with a putty knife and remove the internal antenna (often labeled ANT).

2. In its place, solder a telescoping antenna or a piece of copper wire—no more than 35 inches long for broadcasting within the standard FM transmission spectrum.

# 3. The transmitter may have a resistor, typically marked with an R, to limit the power of the signal. Replace it with copper wire to boost the transmission.

4. Slap a bumper sticker on your ride advertising your station's frequency. You'll soon build a grateful audience of fellow commuters suffering through that traffic iam.

LEARN HOW TO DO MORE AT HOWTO.WIRED.COM

# **Get on a Reality Show**



You don't need to crash a White House party to make it onto a reality TV show. WIRED asked Lynne Spillman, casting director for Amazing Hace and Survivar, what she looks for in wannabe fameballs. Here are three tips for making sure you aren't voted off her island. —M.H.

ACCENT YOUR POSITIVES Let casting know what you've got to offer the ratings gods—be it mad rodent-cooking skills, six-pack abs with their own Ironic name, or a crazy reveal [Surrisel Pim Billionier]—that make you must-see TV.

REVEAL YOUR FLAWS Casting agents aren't looking for perfect qualifications, theyre reveal (surrisel say on, lift is television, after all.) So interes do trouting your backpacking expertise, tell a story about the time you are someone's atsain of energy bars at the youth hoster—and planned! to a glir who bard ye spoke English.

B.Y.O. BRAMA Viewers tune into Amazing Race to watch relationships, not relay races. Casting directors look for impending drams. Choose a teammate with whom you have an unsettled and complex history, if you can pull! to ff, fake-fight during the audition. Who knows? After a few days of navigating racedibooks, you might be doing for for sell.

# CLIVE THOMPSON I'd Rather Be Texting

Fiddling with your phone while driving is deadly. So park your car and take the bus.



TEXTING WHILE DRIVING is a huge problem in the US. We know it's insanely dangerous. Studies have found that each time you write or read a text message, you take your eyes off the road for almost five seconds and increase your risk of collision up to 23 times. The hazard is "off the charts," says David Strayer, a University of Utah professor who has studied the practice. "That's why states are

frantically trying to ban it. Nineteen already prohibit texting while driving, and plenty more-including West Virginia and Missouriwill likely join the pack next year. I But I'm not convinced the bans will work, particularly among young people. Why? Because texting is rapidly becoming their default means of connecting with one another, on a constant, pinging basis. From 2003 to 2008, the number of texts sent monthly by Americans surged from 2 billion to 110 billion. The urge to connect is primal, and even if you ban texting in the car, teens will try to get away with it. 9 So what can we do? We should change our focus to the other side of the equation and curtail not the texting but the driving. This may sound a bit facetious, but I'm serious. When we worry about driving and texting, we assume that the most important thing the person is doing is piloting the car. But what if the most important thing they're doing is texting? How do we free them up so they can text without needing to worry about driving? The answer, of course, is public transit. In many parts of the world where texting has become ingrained in daily life-like Japan and Europe-public transit is so plentiful that there hasn't been a major texting-while-driving

crisis. You don't endanger anyone's life while quietly tapping out messages during your train ride to work in Tokyo or Berlin.

Rich Ling, a sociologist who studies the culture of texting, grew up near Denver but now lives in Oslo with his family. He told me that Denmark has so many buses and streetcars that teenagers often don't bother getting their driver's license until later in life. "My daughter is 18, and she's only sort of starting to think about driving," he says. As a result, texting while driving "isn't as big a deal."

In contrast, US cities and suburbs have completely neglected their public transit. With very few exceptions—New York and Boston are two—buses and trains are either nonexistent or wretchedly inadequale. People desperately need cars to shop, work, and meet up with friends. Which is precisely why we're in a crisis: Two activities that are both central to our lives are colliding.

of course, you could argue that texting shouldn't be so culturally central to people and that they should just cool it in the car. You may well be right, but good luck convincing them, my friend. And anyway, there are other benefits to making the streets safe for texters: Dramatically increasing public

transit would also decrease our carbon footprint, improve local economies, and curtail drunk driving. (Plus, we'd waste less time in spiritually draining bumper-to-bumper traffic.)

Texting while driving is, in essence, a wake-up call to America. It illustrates our real, and bigger, predicament: The country is currently better suited to cars than to communication. This is completely bonkers.

By all means, we should ban texting while driving, or at least try. But we need to work urgently on making driving less necessary in the first place. Let's get our hands off the wheel and onto the keypad—where they belong.



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#### BearVault BV500 Food Container

winto None of our testers made any headway with this 700-cubic-inch storage drum, even though they could see and smell the food inside of it. The curved adages were impossible for critters—even the orrangutans, who have twice as many opposable thumbs as humans—or gift, cilew, or bite. TWAE Perforated and seather than the curve of the country of the country of the country of the curve of the country of the co

#### BearSaver PC-95 Poly Cart

winter Peinforced and complicated discurse frustrated all comers. Interior remained impervious to attacks by bear, orengutan, even the UPS guy. Holds 95 gallons of crittertempting refuse. Transc Even for a human, if s much trickler to open than a standard trash our melling trickler to a per transcription of the complex kilds. Asia yielded to bamboo pry bar, unsuitable for areas with serious spe infestations. \$170

#### Ursack S29 AllWhite

WINED Stayed clinched ageinst our grizzly's grimace, despite bearing the brunt of the bruin barrage. Even effer the assault, the sack was still completely usable (but smelled terrible). By far the most portable option: less than 80 unces and about as bulky as an extra layer. Trace Yogin my not be able to the still thin something you would read, but he can mesh it would be supported to the same production of th

#### Yeti Tundra 45-Ouart Cooler

to work on a rugged cooler.

WINE A Mammable snowcoaler fook a primal beeting but kept our food secure. Locks and hinges held tight against Kong's brutal embrace. Withstood 20-foot forgs, pounding, priying, underwater dunks, rock smashing, and hardcore orangutan love. THECA pos managed to right flubber closures and punch holes in the bottom. The drainage spigot didn't put up much of a fight and would make post-traumed.

would make post-trauma use inconvenient. \$280

# **Going HUNGRY**

The animal kingdom is full of thieves. Don't let them swipe your grub. - Mathew Honan

More than 400,000 bears roam the US, and they're all hungry—particularly particularly calorie-dense human food. As they pad quietly through suburbia (and as you camp not-so-quietly on their turf), run-ins are on the rise. But so, too, is a nascent bearproofing industry, which aims to protect half-eaten Krispy Kremes and wilderness provisions from the ursine menace.

We tested four bear-resistant products—a Bear-Vault food bin, a 95-gallon trash can from Bear-Saver, Ursack's food bag for backpackers, and a Yeti ice chest-by filling them with peanut butter, fruit, and honey and dropping them in with Besty, the Presco-Chaffee Zoo's 500-pound grizzly. She acted just like a wild bear, going from product to product boking for the easiest entry. Betsy gave each a quick paw and nibble, then set her 4-inch claus and 2-inch cannies on what she deemed

the easiest target: the Ursack. Yet after half an hour of unsuccessful nom-noming, she gave up and opted for a 19-hour nap instead. Bears are lazy.

Orangutans are not. What's more, their strength is legendary, and they're exceptionally smart. Even better, "they re the most destructive animals here," promised zoo director Scott Barton. Perfect. We took our gear away from Sleeping Beauty, rebaited it, and gave it to the great apes.

Busar, a 275- pound dreadlocked male, a made a determined but unsuccessful effort to pry open the cooler using his fists and feet (then spent the rest of the time balancing it on his face). Alex, a smaller female, was more methodical. She bit off everything that wasn't flash, slammed the products on concrete, and battered them with rocks. She even punched holes in the cooler bottom with an axle she ripped off of the trash can. But all containers held steady, Not a single damn dirty ape laid a stinking paw on our snacks. Human ingreuity: two; Johnson marauderis; zin, unity: two; Johnson marauderis; zin,

#### How We Rate

A complete failure in every way
Bearly functional—don't buylt
Serious flaws, proceed with caution
Downsides outweigh upsides
Recommended with reservations
Asolid product with some issues
Very good, but not quite great
Freelent with complete the complete of the complete

Nearly flawless--buy it now

.Metephysical product perfection

Yei Tudir di-duiri Coler YETI

...











locetes our weyward writer.





The wilderness is a lot less wild when you carry a satellite tracker. — Joe Brown

HOW DO YOU TRULY TEST a device that beams your coordinates into space and dispatches a rescue squad to your exact location? You get lost. And that's exactly what I did-in Tahoe National Forest, an 800,000-acre home to bears, coyotes, mountain lions, avalanches, subzero temperatures, gale-force winds, and, for a weekend in December, a WIRED satellite office.

The Spot GPS Messenger, which is about the size of an '80s-era pager, relays your exact latitude and longitude to one of 48 orbiting satellites every 10 minutes. You can set the device to automatically upload this data to a Web site so your buds can follow your crazy adventures; you can push a button to send canned messages from the middle of nowhere, assuring your parents that you're OK; you can even call for roadside assistance (for an extra \$30 a year). WE ASSUME WHAT
YOU ARE DOING ON
YOUR PHONE IS TOO
IMPORTANT TO BE
OBLITERATED BY A
PICTURE OF YOUR
BUDDY'S SCHNAUZER.

Which is why Droid has a notification panel. Designed by Google. A zero-interruption way to see your messages. From pointless to meaningful. Without actually having to open them.











Spot Satellite GPS Messenger
wire b Water- and shock-resistant. Comes

wixeD Water- and shock-resistant. Comes with handy am star. File-ap- covering \$11 button flowed minimize files alarms. Sawd with water year through minimize files alarms. Sawd in the woods. 30 percent amalier than previous generation name operation sawd coording blinking lights takes a lot of work—especially when you're freeking out. Bid that message go through? Is fell you the move? There's no way to know. Hidden fee alert. \$10.0 s year sawd to know. Hidden fee alert. \$10.0 s year service). Uses only disposable lithing service). Uses only disposable lithing to find in the clay with the same you're free the wilderness. \$160 s





But the gizmo really shines in an emergency. Flip open the SOS safety cap to hit the 911 button and Spot will fire off an urgent message to the GBOS International Emergency Response Center in Houston, GBOS will then figure out the best purveyors of rescue cops, Coast Guard, US embassy, or, in this case, Tahoe Nordic Search and Rescue, a volunteer group of snow-happy badasses located in Placer County, California.

A word of caution: Please don't try this. Ever. I spent months working with Spot, GEOS, and TNSAR to coordinate this exercise. At no point was anyone under the impression that I was in real danger.

Still, planned or not: If I had to be the rabbit, I'd be no easy meat.

I set off into the woods in the pitch-dark part of the morning that's not really morning at all, doing my best to cover my tracks by scrambling over rocks and packed snow. When I couldn't avoid the waist-deep powder, I donned snowshoes and obscured my

footprints by dragging branches. After 30 minutes of walking, with "up" as my only directive, I was completely lost in the moonless, freezing night.

After eight hours, about 10 miles, and several thousand feet of ascent, I was not only disoriented but also dog-tired and hungry. If it weren't for the knowledge that help was a button-press away, I never would have ventured this deep into a strange formers. More than once I emerged from a stand of trees to face sheer drops and avalanche chutes. The bear tracks didn't do much for my already altitude-elevated heart rate, either. With food, water, and toes frozen, I pulled the pin on the rescue grenade and plonked down to await salvation.

It arrived about 30 minutes later: four snowmobilers, a gaggle of cross-country skiers, and a snowcat. They strapped me into a backboard and soon had me warming in the back of the diesel-powered cat. In the satellite age, lost is a relative term.



#### Meet the all-new 2010 GTI. Yes, it's street legal.

The German-engineered GTI will once again lay rubber on American asphalt. With design inspired by the original Mark I, the GTI serves up sharp looks and even sharper performance. The legendary German hot hatch features cutting edge technology that's new for 2010. Like XDS, a highly advanced differential system that helps reduce wheel spin, keeping your Volkswagen safely on track. Add in aggressive with ratiplipes and 31 mpg highway, and you have a GTI that lives up to its award-winning namesake. Hurry in, the all-new 2010 GTI is going to go fast. Real fast.



Das Auto.





3 Years or 36,000 Miles of No-Charge Scheduled Maintenance. Whichever occurs first. Some restrictions. See dealer or program for details.

# **Under FIRE**

Bulletproof vests are one of the most extensively tested products you can buy. That just means we had to kick everything up a notch.

—Kelsey Hazlewood

THERE'S ONLY ONE WAY to lest a buildetproof vest. with bullets. Of course, any vest worth its hefty price tag has already been certified by the National Institute of Justice, so you can be pretty confident it'll work. But just how much pain will you experience while having your life saved? And what if someone decides to subject your vest to more punishment than it's designed for? In the world of "builet resistance" (no garment is truly builetproof), the term over/ill takes on special significance. 9 The NIJ recognizes six levels of ballistic protection for body armor; IIIA is the highest rating a soft garment (one with no metal plates inside) can attain.



## BREATHLESSLY OBSESSING AT SONY CES

Excitement reached a fever pitch in the Sony booth at CES this year, with the introduction of exciting new technology, from cameras to consoles, that can turn anyone's creative dream into reality. We took the temperature of attendees and the results were off the charts — everyone was fired up over the intersection of stunning new content and devices.



The buzz was coming from all sides at Sony's CSS booth this year. but the most repected princes was "30" by far. It's true: Among Sony's latest sturners are the 3D-enabled HD televisions, as well as a few Birt-roy Disc" players and PS3" games. Taking home entertainment to the next level, these TNs combined with a 3D emitter and Active Shutter glasses raceta a fully dimensional experience right in the Iving room. Eye-popping move effects and a few PS3" 3D-enabled games an demo sported arows of enthusiatic showagers gushing about the realism and thrill. Startling sports plays took on a life of their own, and Sony's portnership with ESPN and Discovery Communications this year will ensure plenty of content actions.

#### MONOLITHIC GOES META

Sk degrees may sound small, but in futil it separates the Monolithic from the mundane. A six-degree upwards till on the new BRAWA\* Monolithic Design IVs creates a natural anglie for maximum viewing experience, while an almost invisible bezel and hidden touch sensors integrate seamlessly into any décor. Showpers registered double-takes at the water-thin Monolithic monitor profiles, peering at panels sidelong to believe they were actually that thin: Yet for all the sleekiness, the screens come bizzing to life with not color and realistic high definition supported by backlif Life Dechnology.



SONY BRAVIA® LX900

#### READER DAILY EDITION™ KEEPS IT CURRENT

Today's news moves (ast, and CES attendees were thrilled to find a way to tap Into the network with the Reader Daily Edition", wirelessly subscribing to user-selected content and displaying it in a single elegant device. "With a 7" poper-like display, touch screen novigation and adjustable front levels, the Reader Daily Edition supports multiple formats. Books and periodicals are available to purchase and download, including exclusive content and daily updates from The Wall Street Journal, Financial Times, Los Angeles Times and Chicago Tribune.

#### DISHING ON DASH™

A little bit of this, a tittle bit of that; Everyone was delighted and charmed by dash\*\*, a personal internet viewer, which packs an infinite amount of content into a single, flay device. Perfect plugged in at the kitchen counter or on the bedside toble, it can display over a thousand free apps and stream favorite internet content with a simple wireless connection and 7" diagonal LCD touch screen intuitive interface. Whether it is wake-up weather and fraffic, music videos, or synchronous social networking, or personal photo sharing, this device can do it all.

# OVERHEARD AT CES

Event-goers shared their thoughts on the buzz from the show floor.

"The one thing that's really cool with the PSP G is that you can download everything straight to the console and you're Good to Go."

technology is truly. truly technology is truly. truly especially when it comes to sports and live events."

"What really caught my eye were the brand new Cameras from Sony that have auto HDR, which

is really impressive to me."



■ SONY READER DAILY EDITION™

"Sony is bridging the gap between the super-experience and the convenience of technology in the home. And they're getting smarter — soon every gadget and appliance in my house will have a single interface through which I can talk to all of them. Then I'll only have to worry about losing one remote."



SONY DASH



**Q+A**Alexis
Ohanian,
Co-Founder
of Reddit

The creative force behind the highly successful reddit.com, Alexis was our "Man on the Floor" this year at CES. We caught up with him to find out what he personally found inspiring and intriguing.

#### What were people most excited about?

3D. Watching football games with the glasses on really blew people away. One of my standard questions was, "What da you want to take hame?" and my own answer would probably be a 3D TV.

#### More tech than ever is devoted to consuming entertainment in the home. What was your tavorite?

I was pretty enthused about dash", a personal internet viewer—totally simple interface, easy setup. I can see pictures from my last frip, get the weather report—basic stuff consolidated in one piace. It just warks. There's a lot to be said for simplicity.

#### You're an entrepreneur — did you see anything that could help people make something big?

It's all just getting so much smarter and convenient. Which, if we're smart, allows us to make better use of our time. We're in control of how and when and where we consume media. We can da more than imagine; with these took, we can actually create.

### You were part of the social media revolution. What did you see at CES that had potential to be part of the next tech revolution?

Saamless Integration between devices in the harme. Some at the eatting, or sen are area to most Trigon horses from the future—like the Sarry' game consides initially they were created just for playing games. Witelessly enabled so I can netwark with other players, such but now as more technicagly becomes ovalidable I can stream novies or pull my photal birary across my harme netwest to display on my IV. There's a wealth of great data now that's all slaced off, but in carning years will be inter-accessible and more early leveraged.

"From a content developme and partnership perspective, Sony has some really interesting things going on..." "I think the 360 degree lens on the SONY Bloggie HD Camera is

## SONY

make.believe

Visit wired.com/manonthefloor for exclusive videos from the 2010 Consumer Electronics Show 2010 international ces

# man 3

# DIDN'T MAKE IT TO THE CONSUMER ELECTRONICS SHOW?

Not a problem. Man on the Floor brings you an inside look at the 2010 show. Turn the page to read about the topics, technologies and future trends that sparked the most imagination.

Brought to you by

SONY make.believe

Sony was trunded on a belief that dreams can be made into reality. Whether it's a song in an artist's head. A director's vision. An idea to a game. Or a picture you'd like to capture – Sany supplies the tools at the tuture to make your ideas a reality. It's that history at callabration and innovation that continues today, in electranics, tolevisian, mation pictures, musto and gaming. Because ideas need nurturing. And magic happens when ineignation and reality callids.

Believe that anything you can imagine, you can make real.

SONY make.believe Naturally, that's what we chose to test.

We began by the book, at the Oregon Ballistics Lab-one of five NLJ-certified facilities in the US. Instead of strapping the vests on an intern (author's note: that would be me) and emptying a clip, the folks at OBL mounted the armor on a 220-pound block of modeling clay and used a mechanized rig to punish each with six .44-caliber and six .357 rounds. No need to count cracked ribs; to gauge impact, we simply measured the resulting craters. The greater the deformation in the clay, the greater the deformation would be in your chest.

The NIJ tests were awesome, but this evaluation wouldn't be extreme if we didn't crank it up to 11. So we enlisted the help of a friend, Mac Castle, who has a firing range in his basement and was nice enough to go just a tad more, er, hallistic on our test subjects.

Castle subjected each yest to six more .44-caliber slugs, some of them 25 percent heavier than the .44s at OBL. The bullets did some ugly damage, but we never had a vest truly fail. Good thing, too; in this category, we like a bit of engineering overkill.



#### Bulletproof Bodyarmor HO Vest

WIRED Talk about protection: The dimples left by the .44-caliber rounds in our leb tests were so negligible, the techs didn't deem them worthy of measurement. Held up even when Cestle shot it twice in the same spot. Simple, concealable design, Least expensive vest in the group. TIRED Some bullets left sharp plestic edges protruding from the point of impact. But you wouldn't wear e vest that's already been shot enyway. Besides, the low price on this one makes

replacement a no-brainer. \$344



#### Miguel Cahallern Polo

WIRED Even after 12 rounds, ballistic material was still shrugging off slugs with ease. The polo-shirt exterior stayed cool under fire, with only small holes that you'd have to get pretty close to-we're telkin' knife-range close-to notice. TIRED Even James Bond's Q Branch might balk at the nearly 5-6 price tag. The shirt doesn't really hide the armor underneeth. so you're still gonna need that sketchy trench coat. So much for being inconspicuous. \$4,490

#### RulletProofMF.com lacketVest

WIRED Comes zipped inside a warm and comfy L.L. Bean jecket, making it easy to wear in public without blowing your cover/ attracting the attention of Homeland Security. The lightest yest tested. TIRED Ouch! Clay indentations were at least 25 percent deeper than with the others. One bullet did go clean through, but since it was close to a previous hit, official NIJ tests would have forgiven this failure. Good thing realworld gunshots are so thoughtfully speced! \$760 as tested

# Slippery road behind.



The Subaru Legacy. As carefree as winter driving can be. Symmetrical All-Wheel Drive helps you stick to the road better than the fattest of snowflakes. A Stability and Traction Control System keeps you going in the right direction. The result is a fletling that's harder to shake than the road itself. Love. It's what makes a Subaru, a Subaru.



Legacy." Well-equipped at \$19,9951

MSRP excludes destination and delivery charges, tax, title and registration fees. Dealer sets actual price. Largacy 2.5 Lumited pictured has an MSRP of \$24.985.



#### Clash of the Titans (Blu-ray)

The work done by f/x pioneer Ray Harryhausen on the 1981 classic Clash of the Titans reminds us that every exploding space station, acid-bleeding alien, and freeway-smashing robot owes a debt to the stop-motion animators and model builders of yore. Now, thanks to a shiny new Blu-ray transfer, you can relive the menacing scorpions, Medusa's serpentine coiffure, and Bubo the mechanical owl in Aphrodite-worthy 1080p. It'll get you primed for director Louis Leterrier's big-budget remake (starring Avatar's Sam Worthington), which hits theaters March 26.

#### NumberGossip.com

Psst ... did you hear that 14 is the smallest number n such that n and 2" end with the same digit? Or that 27 is the smallest of only two known cubes made up of prime digits? At this site run by a PhD who won the gold medal at the International Math Olympiad, you enter any positive integer below 9,999 to get the inside dirt-exploring numerical phenomena like hungry numbers, Mersenne primes, and 47 more. It's TMZ for mathletes!

#### What's wired this month.



WTF With Marc Maron A veteran comedian and rabble-rouser, Maron doesn't so much interview his podcast guests-fellow comics, celebrities, friends, family members-as rant with them about the frustrating (and funny) side of technology, politics, and relationships. The twice-weekly jabfest is profane and highly entertaining.

# Plopp Stool

Inflatable metal?! The Plopp stool from Polish artist Oskar Zieta is made of two ultrathin steel plates welded around the edges and pumped up under high pressure, turning what might otherwise be cheap furniture into beautiful, functional sculpture. Pick one up for about \$460, from Danish furniture com-

pany Hay, hayshop, dk

#### Danger Mouse and James Mercer: **Broken Bells**

Danger Mouse's "I'm the DJ, he's the singer" formula in Gnarls Barkley wasn't broken, but the artist also known as Brian Burton went ahead and tweaked it anyway-to great effect-with his latest project. Here he shares instrumental duties with the Shins' James Mercer, whose understated voice melds perfectly with the music's moody melodies and laid-back vibe. Crazy good stuff.



#### Stolen Moments

Some people might sneak a peek into a stranger's apartment when they walk by, but photographer Yasmine Chatila stops and stares. She spent months staking out uncovered windows in New York City for her voyeuristic series, Stolen Moments. The black-and-white results contrast intensely personal scenes with Manhattan's very public architecture, tinvurl.com/stolenm

#### Sisterworld

These stylistically (and geographically) unpredictable con artists deliver on their only quarantee; dramatic. powerful music. Liars' fifth LD charts a delicate course between sparse, droning vocal arrangements and the trio's trademark barrages of postpunk polyrhythm.



Croatian designer Robert Matysiak wrings a lot of personality out of plastic plumbing parts and electrical conduits. Use his handmade, robotinspired lamps to read by, or as cheery companions. A custom Robolamp will run you anywhere from \$70 to \$200. depending on the size and design.

#### Biology Is Technology In this new book. bioengineer Robert H. Carlson forecasts the rise of

the cell and the subsequent emer gence of biological techniques for making fuels, synthetic DNA that builds new organisms, and reverse-engineered viruses for making vaccines. Biologists, Carlson says are the new engineers, and the future is in remodeling life as we know it.

#### **Ultraviolet**

Turn on, tune in, and open up this trippy book, subtitled 69 Classic Blacklight Posters From the Aquarian Age and Beyond. Marvel at how a simple phosphor coating can make a normal lightbulb emit UV rays undetectable to the naked eye, causing the fluorescent inks of these vintage posters to glow. Or just sit back, relax, and be, man.



# **IPA** THE BEER RANGER WAY

0



They protect. They pour. They partake. They are the many and the only New Belgium Beer Rangers. We salute their efforts in the field with the extra-hopinary Ranger IPA. Three pounds per barrel of Simcoe, Chinook and Cascade hops make this 70 IBU brew a thing of natural beauty. Seek out the

Beer Ranger in your territory at newbelgium.com.

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# **Bit Parts**

Remember that scene? With that guy? Find your favorite clips—fast.



IMDb will end most late-night, friendship-straining stalemates over who wrote Scarface (Oliver Stone!), But what if you have a brain-freeze about piece of dialog: You know, when that one guy with the guns says the thin at that place? Your pursuit of the perfect sound bite all too often you down a Google-YouTube-BitTorrent rabbit hole, Well, a new crop of videoclip sites are streamlining that process, serving up the exact scene or even line-you need. Call it celluloid by the slice. I Launched















- B. "You're cool, fuck you, I'm\_
- C. "Gentleman, you can't \_\_\_\_ in here, this is a war room.
- D. "Nobody fucks with the
- E. "The price is\_\_\_\_ . bitch!"
- F. "Say hello to my little\_ G. "These go to
- H. "Did you see the \_\_\_\_about this?" I. "You mess with the \_\_\_\_ you get the

(Office Space); I. bull/horns (The Breaktast Cilub). Coanace); G. eleven ( Inisis Spinal Iap); H. memo Lebowski); E. wrong (Happy Gilmore); F. friend C. fight (Dr. Strangelove); D. Jesus (The Big Answers: A. me (Taxi Driver); B. out (Half Baked);







in December, the free Movieclips service feature 12.000 classic film excerpts—from It's a Won derful Life to The Big Lebowski, Sear by acto

300 titles, mostly indies, at South by Southwest in March, Anyclip uses a scene-by-scene index ing system, and a crowdsourced video-edition option lets users cut clips themselves or adadditional search tags to improve the service Major studios are also getting in on the act

Both Paramount and Universal are uploading content to searchable marketplaces where advertisers and broadcasters can license clips for few grand a pop. Paramount might eventually make these clips available to the masses as pay per-cut downloads. So the next time you want to say hello to your little friends, you can let Ton Montana do the talking, - MARIO AGUILA

#### SCREEN



#### GRMES



# **Up in the Air**

Cloud-based game services promise to be the next big thing—if they work.

How'd you like to play the latest processor-intensive PC game on your decrepit old Mac laptop or even your iPhone? That's the tantalizing promise of cloud gaming, which purports to offer instant play without discs, software installations, or lethal clamshell packaging. The only requirement is a broadband connection. Here's how it works: The inputs from your joystick or keyboard are streamed to a central location, where Herculean servers and graphics processors run the game. Video footage of the gamenlay whooshes back to your monitor in real time. It could revolutionize game publishing, eliminate piracy, and put console manufacturers out of business. The only issue? Some experts believe it's technically impossible. Here's a look at three competing pioneers currently in beta. - David Kushner

#### OnLive

The promise: Stream games to any computer with broadband. (To play on a TV, you'll need a converter.) Games: Titles from most major game publishers. Reality check: "Is OnLive OnCrack? If they want to serve 20,000 oppopels, they'll need 20,000 computers or the equivalent thereof. That's \$20 million just to start," worte CrunchGear.

#### Gaikai

The promise: Browser-based PC streaming service. Games: "We have *World of Warcaft* and *EVE Online* running," claims CCO David Perry: "Reality check: "If you dig down ... there's nothing concrete, just hypotheticals," says EuroGamer.

#### Otoy

The promise: Cloud service that runs in any browser, including Safari for iPhone. Games: No specific titles mentioned, but they also talk of streaming CAD software and HDTV. Reality check: GamesBeat called competition between Otoy and OnLive "the battle of the hucksters."





Macoto Murayama can spend months on one of his botanical illustrations, and when he's done, the plant looks like something that blossomed in outer space. First, he dissects his subject with a scalpel, from stamen to sepal. Then he sketches and photographs each component with the help of a basic microscope and magnifying glass. Once it's all composited with 3ds Max and Photoshop, the resulting images seem equal parts x-ray and autopsy. ¶"There's an overwhelming charm in the detailed drawings of both plants and machines," Murayama says. "Machines have an organic side, while plants have a mechanical side." In some of his pieces, labels and measurement scales hint at traditional botanical sketches. On others, the ghostly skeletons and hypnotic symmetries speak for themselves. -Sonia Zjawinski

RRTS



#### PRINT

## Paranoid Activity

It's easy to create a conspiracy theory: You just need the right formula. Moon landing? Hogwash-a hoax to distract the public from the Vietnam War. Princess Diana's car accident? That's rich. The Royal Family clearly had her offed-as blithely as if it were removing a thorn from its highborn flank. 9 At least that's what conspiracy buffs believe. And there seem to be more of them than ever. London Times columnist David Aaronovitch says that our rampant infoculture provides a breeding ground for crackpot theories. Take the Web's unique ability to lend unverified assertions an air of authority, add a dash of political instability, and you've got the ultimate medium for propagating alternate realities. "It's more bearable that terrible events should be the result of a big conspiracy than the blind cruelty of the world," says Aaronovitch, whose new book, Voodoo Histories (Riverhead, 2010), chronicles several of the 20th century's most prominent conspiracy theories. "These stories are better than reality." 9 But coming up with them isn't just a matter of blaming the Freemasons: Aaronovitch identified six must-have ingredients, which are spelled out in the sample below. Use them to generate your own wild idea, or plug in the details at right for a premade plot. But be careful—they're watching you! -JOE BROWN



#### The Conspiracy Generator

Complete the framework below with one of the sets at right—or fill in the blanks yourself—to construct an airtight, logic-proof plot.

Are you kidding me? [event] was a total sham! Think about it! Everyone knows that [appeal to precedent]. And have you noticed that [ruling site] has started to act very stranegy? They obviously don't want this story getting out. I mean, what would happen if people began asking [disturbing question]? Well, they may be able to fool the sheeple, but the members of [declated group of truth-seekers] aren't swallowing interest story. Look, don't take it from me; [expert endorsement] is convinced as well. But we have to act fast, because [suggestion of imminent threat]. I just wanted you to be aware of this, moase I disappear.

#### The death of Lady

DI / faked car accidents are a favorite means of assassination / the British Royal Family / what really caused the 1999 fire in the Paris Palasside Justice (the Al Fayed family / former milk agent David Shayler / there are legions of fanatics who will do whatever it takes to protect the British monarchy

The moon landing / governments always try to divert attention from unpopular wars / the CIA / to see the high-quality video of the first moonwalk / The Flat Earth Society / self-published author and former Rocketdyne librarian Bill Kaysing / just look at what happened to Kennedy

9/III / George W. Bush ust wanted to finish what his father began / the oil industry / why the entire national air defense system shut down on the day of the attacks / 9IIITruth.org / University of Western Ontario professor A. K. Dewdney / as long as the wars in Iraq and Afphanistan rage on, proponents of the truth are in danger.

**REPO MEN ARE COMING** 

#### JOIN THE REPO MEN AND YOU COULD WIN UP TO \$30,000

For a price, any organ in your body can be replaced. But it can also be renossessed

In REPO MEN, a futuristic action-thriller starring Jude Law and Forest Whitaker, humans have extended and improved their lives through sophisticated and expensive mechanical organs created by a company called The Union. The dark side of these medical breakthroughs is that if you don't pay your bill, The Union sends its highly skilled Repo Men to take back its property...with no concern for your comfort or survival.

Here's the question: Are you smart enough and sharp enough to join the Repo Men? Beginning February 25th, we are looking for qualified applicants to hunt down artificial organ recipients whose payments are past due. Repo Men can earn generous cash bounties of thousands of dollars for each recipient they track and catch.

To find out if you have what it takes to be Repo. go to www.wired.com/repomen. All bounties are open to registered Repo Men only. Repo Men must abide by all rules and regulations in order to collect bounties.

Four clients possessing Union-owned artiforgs have defaulted on their payments. They are now on the run. Your job is to track them down. And remember, Repo Men earn their stripes by paying attention to clues, and by the sweat on their necks.

THE HUNT BEGINS...NOW.

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#### MOTOR



## Blasts From the Past



We check in with our favorite '80s movie stars

John Whosack? Michael J. What? We couldn't care less about the whiny dweeb protagonists of '80s cinema. The real heroes of that high-octane age were the wheels—mechanical masterpieces that, if not perfect right off the assembly line, were amped and revamped until they were bitchin' enough to save (or ruin) the day. We caught up with our favorites to see what they've been up to. Is that you, Christine? Gosh, you haven't aged a bit! - Anna Goldwater Alexander

#### 1958 Plymouth Fury

Christine (1983) There are three Christines still in existence, all owned by obsessed fans-just the way we like it. One psycho sister car is skulking in the UK, but two remain stateside. Bill Gibson of Pensacola, Florida, nabbed his in 2005. Martin Sanchez of Woodcrest, California, bought his-a wrecked stunt car-right after the film's release and put her back together again. (Don't worry, Mrs. Sanchez is fine.)

#### Kuwahara BMX

ET: The Extra-Terrestrial cons Tom Meighan, vocalist for the British rock band Kasabian, thought he bought Elliot's bike in 2007, But Steven Spielberg's people say the director held onto all the alien-blessed Kuwaharas Too had because Meighan makes the most of his ride: Word is that the singer likes to reenact the final escape scene in his sprawling flat. That thing is never gonna fly, Tom-it's a fake!

#### 1959 Cadillac Miller-Meteor Hearse

Ghostbusters (1984) Sony execs loved the two ahoul-aetters from the Ghostbusters films so much, they stashed the original movie cars in a secure location and made a replica for the studio tour. Jim Hedges of Galion, Ohio, bought the ersatz Ecto in 2008 and auctioned it off to an anonymous collector in January. Who you gonna call? The guy who shelled out 80 grand for a gussied-up hearse.

#### DeLorean DMC-12

Back to the Future (1985) Six Del oreans were used to film the Marty McFly trilogy and the locations of four are known. Two are tram-tour heroes at Universal Studios: one is fastened to the ceiling of a Planet Hollywood in Honolulu. The fourth was rotting in a studio back lot until an anony: mous collector in San Jose, California, picked it up at auction. The gullwinged sportster is now being restored to reverse the effects of time.

#### 1967 Camaro SS

Better Off Dead (1985) After carrying a torch for Lane Meyer's black SS for almost 20 years, a Camaro lover in Florida tracked down the car from a license plate that's barely visible in the film. He hired a gumshoe to find the unwitting owner, bought the faded hulk in 2002, and spent a year fixing it upsadly, without the help of a beautiful French exchange student. Now it's cruising the showcar circuit.



# IRONICALLY, INDIVIDUALITY IS NOT A TRAIT SHARED BY EVERYONE



# 75

# Lifesavers



Death is inevitable. But your digital self can live forever! Hamlet, that lucky stiff, only had to worry about being or not being—what a nice, binary Denmark he lived in. We modern mopes, on the other hand, must consider not only our too, too solid flesh but also our online infinitude: From banking to book-buying, from Facebook pages to busty Warcraft avarats to scrupulously Tumblr'd "bucket lists," we leave our sili-

con snakeskins scattered from here to tim.buk.tu. In a sense, it's the realization of William Gibson's Neuromancer fantasy. We've been uploaded! To the cloud Our local, carbon-based "hard drives" may fail, but vestiges of our inimitable selves will remain ambient and accessible long after we log off this mortal coil.

This distributed deathlessness means we'll all need a little cleanup on Aisle Me. The aspects of life we archive online, be they valuable. heritable, or simply embarrassing, require posthumous management (and, in some cases, eradication) lest our friends and loved ones and executors be embarrassed or inconvenienced by our lingering digital detritus, a trash-strewn wake of left-behind liabilities. At least three companies-AssetLock .net, Legacy Locker, and the charmingly named Deathswitch .com-have arisen to keep customers' passwords, usernames. final messages, and so on in a virtual safe-deposit box. After you're gone, these companies carry out last wishes, alert friends, give account access to various designated beneficiaries, and generally parse out and pass on your online assets. Digital remains that are not bequeathed to an inheritor are incinerated, closing the book on PayPal accounts, profiles. even alternate identities (especially alternate identities: You don't want your mother knowing about, or worse, playing, the wife-swapping giant badger you became in Second Life).

Here's how it works: For around \$10 to \$30 per year, or \$60 to \$300

for a lifetime-prices depend on the services you want and how much you're storing-these companies organize and store all Net-borne Protrusions of You. Deathswitch requires you to prove your continued existence regularly-daily, even, if you choose. (Legacy Locker requires two human "verifiers" of your demise.) Once it's determined that you're fully and finally degaussed, your probate probes fan out across the Net, making your last epayments, Old Yellering your avatars, perhaps even euthanizing your FarmVille stock, and, ultimately, sending sign-off messages

to friends, followers, frag-buddies, and hookups: "Status update: I'm dead. It's been real!" (Listed under Common Deathswitch Uses are "passwords" and "bank records," but also "unspeakable secrets," "love notes," and my favorite. "final word in an argument.") Presumably, you could use these services to reward/punish the living, just like a traditional meatspace will: Leave your favorite daughter your fully loaded WoW blood elf, and deed your hated brother that spam-choked AOL address you used for all your most dubious registrations.

Now, while I admire the Kierkegaardian pluck and fearless pragmatism of these services. I also find them super depressing. I didn't embalm every single moment of my life in digital images and text chunks just to see it all fastidiously trashed or divvied up among the still-living. Which is why I'm awaiting the next generation of iDead technology: the inevitable online necro-puppetry industry. Such a service would keep me, or the appearance of me, alive online in perpetuum. Statuses will be updated from a pool of preselected terms ("hangin'." "chillin'," "watchin'") that can be randomized and recycled. Believably mundane tweets will be released in intermittent bursts mapped to current American Idol contestants. Credibly tacky items will be autopurchased on eBay, using the complex bidding strategy I employed in life (i.e., "Buy It Now!"). Why continue to "live" this way, a mere shadow of one's former self? Because maybe it's more than a shadow. Maybe it's enough of a self to be worthy of life support. And I'll take some semblance of life over none at all. [1]

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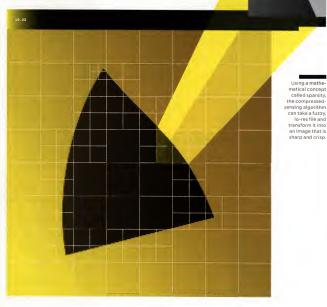




#### F\_ll \_n t\_e Bl\_\_ks

A revolutionary algorithm can make something out of nothing.

BY JORDAN ELLENBERG



N THE EARLY SPRING of 2009, a team of doctors at the Lucile Packard Children's Hospital at Stanford University lifted a 2-year-old into an MRI scanner. The boy, whom I'll call Bryce, looked tiny and forlorn inside the cavernous metal device. The stuffed monkey dangling from the entrance to the scanner did little to cheer up the scene. Bryce couldn't see it, in any case; he was under general anesthesia, with a tube snaking from his throat to a ventilator beside the scanner. Ten months earlier, Bryce had received a portion of a donor's liver to replace his own failing organ. For a while, he did well. But his latest lab tests were alarming. Something was going wrong-there was a chance that one or both of the liver's bile ducts were blocked. 9 Shreyas Vasanawala, a pediatric radiologist at Packard, didn't know for sure what was wrong, and

Using a mathematical concept called sparsity.

lo-res file and

an Image that is sharp and crisp.

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hoped the MRI would reveal the answer. Vasanawala needed a phenomenally hi-res scan, but if he was going to get it, his young patient would have to remain perfectly still. If Bryce took a single breath, the image would be blurred. That meant deepening the anesthesia enough to stop respiration. It would take a fall two minutes for a standard MRI coapture the image, but if the anesthesiologists shut down Bryce's breathing for that long, his glitchy liver would be the least of his problems.

However, Vasanawala and one of his coleagues, anelectrical engineer named Michael Lustig, were going to use a new and much faster scanning method. Their MRI machine used an experimental algorithm called compressed sensing—a technique that may be the hottest topic in applied math today. In the future, it could transform the way that we look for distant galaxies. For now, it means that Vasanawala and Lustig needed only 40 seconds to gather enough data to produce a crystal-clear image of Bryce's live.

COMPRESSED SENSING was discovered by chance. In February 2004, Emmanuel Candès was messing around on his computer, looking at an image called the Shepp-Logan Phantom. The image-a standard picture used by computer scientists and engineers to test imaging algorithms-resembles a Close Encounters alien doing a quizzical eyebrow lift. Candès, then a professor at Caltech, now at Stanford. was experimenting with a badly corrupted version of the phantom meant to simulate the noisy, fuzzy images you get when an MRI isn't given enough time to complete a scan. Candès thought a mathematical technique called l, minimization might help clean up the streaks a bit. He pressed a key and the algorithm went to work.

Candès expected the phantom on his screen to get slightly cleaner. But then suddenly he sawit sharply defined and perfect in every detail—rendered, as though by magic, from the incomplete data. Weird, he thought. Impossible, in fact. "It was as if you gave me the first three digits of a lo-digit bank account number—and then I was able to guess the next seven," he says. He tried rerunning the experiment on different kinds of phantom images; they resolved perfectly every time.

Candès, with the assistance of postdoc Justin Romberz, cameu pu with what he considered to be a sketchy and incomplete theory for what he saw on his computer. He then presented it on a blackboard to a colleague at UCLA named Terry Tao. Candès came away from the conversation thinking that Tao was skeptical—the improvement in image clarity was close to impossible, after all. But the next evening, Tao sent a set of notes to Candès about the blackboard session. It was the basis of their first paper together. And over the next two years, they would write several more.

That was the beginning of compressed sensing, or CS, the paradigm-busting field





Owning your own business doesn't mean you have to have all the answers.

in mathematics that's reshaping the way people work with large data sets. Only six years old, CS has already inspired more than a thousand papers and pulled in millions of dollars in federal grants. In 2006, Candès' work on the topic was rewarded with the \$500,000 Waterman Prize, the highest honor bestowed by the National Science Foundation. It's not hard to see why. Imagine MRI machines that take seconds to produce images that used to take up to an hour, military software that is vastly better at intercepting an adversary's communications, and sensors that can analyze distant interstellar radio waves. Suddenly, data becomes easier to gather, manipulate, and interpret.

COMPRESSED SENSING works something like this: You've got a picture—of a kidney, of the president, doesn't matter. The picture is

made of 1 million pixels. In traditional imaging, that's a million measurements you have to make. In compressed sensing, you measure only a small fraction—say, 100,000 pixels randomly selected from various parts of the image. From that starting point there is a gigantic, effectively infinite number of ways

lines—is sparse; a screenful of random, chaotic dots is not. It turns out that out of all the bazillion possible reconstructions, the simplest, or sparsest, image is almost always the right one or very close to it.

But how can you do all the number crunching that is required to find the sparsest image

# IF THERE ARE A MILLION WAYS TO RECONSTRUCT AN IMAGE, THE SIMPLEST OPTION IS ALWAYS THE BEST.

the remaining 900,000 pixels could be filled in.

The key to finding the single correct representation is a notion called sparsity, a mathematical way of describing an image's complexity, or lack thereof. A picture made up of a few simple, understandable elements—like solid blocks of color or wiggly quickly? It would take way too long to analyze all the possible versions of the image. Candès and Tao, however, knew that the sparsest image is the one created with the fewest number of building blocks. And they knew they could use  $l_i$  minimization to find it and find it quickly.





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To do that, the algorithm takes the incomplete image and starts trying to fill in the blank spaces with large blocks of color. If it sees a cluster of green pixels near one another, for instance, it might plunk down a big green rectangle that fills the space between them. If it sees a cluster of vellow pixels, it puts down a large vellow rectangle. In areas where different colors are interspersed, it puts down smaller and smaller rectangles or other shapes that fill the space between each color. It keeps doing that over and over. Eventually it ends up with an image made of the smallest possible combination of building blocks and whose 1 million pixels have all been filled in with colors

That image isn't absolutely guaranteed to

be the sparsest one or the exact image you were trying to reconstruct, but Candès and Tao have shown mathematically that the chance of its being wrong is infinitesimally small. It might still take a few hours of laptop time, but waiting an extra hour for the computer is preferable to shutting down a toddler's lungs for an extra minute.

Compressed sensing has already had a spectacular scientific impact. That's because every interesting signal is sparse—if you can just figure out the right way to define it. For example, the sound of a piano chord is the combination of a small set of pure notes. maybe five at the most. Of all the possible frequencies that might be playing, only a handful are active; the rest of the landscape is silent. So you can use CS to reconstruct music from an old undersampled recording that is missing information about the sound waves formed at certain frequencies. Just take the material you have and use l, minimization to fill in the empty spaces in the sparsest way. The result is almost certain to sound just like the original music.

WITH HIS ARCHITECT glasses and slightly poufy haircut, Candès has the air of a hip geek. The 39-year-old Frenchman is soft-spoken but uncompromising when he believes that something isn't up to his standards. "No, no, it is nonsense," he says when I bring up the work of a CS specialist whose view on a technical point differs-very slightly, it seems to me-from his own. "No, no, no, no. It is nonsense and it is nonsense and it is wrong."

Candès can envision a long list of applications based on what he and his colleagues have accomplished. He sees, for example, a future in which the technique is used in more than MRI machines. Digital cameras, he explains, gather huge amounts of information and then compress the images. But compression, at least if CS is available, is a gigantic waste. If your camera is going to record a vast amount of data only to throw away 90 per-

#### **How Math** Can Make Grainy **Images Clear**

Compressed sensing is a mathematical tool that creates hi-res data sets from lo-res samples. It can be used to resurrect old musical recordings, find enemy radio signals, and generate MRIs much more quickly. Here's how it would work with a photograph.



#### 1. Undersample A camera or other device captures only

a small, randomly chosen fraction of the pixels that normally comprise a particular image. This saves time and space



#### 2. Fill in the dots

An algorithm called /. minimization starts by arbitrarily picking one of the effectively infinite number of ways to fill in all the missing



#### 3. Add shapes The algorithm then

begins to modify the picture in stages by laying colored shapes over the randomly selected image. The goal is to seek what's called sparsity, a measure of image simplicity.



#### 4. Add smaller shapes

The algorithm inserts the smallest number of shapes, of the simplest kind, that match the original pixels. If it sees four adjacent green pixels, it may add a green rectangle there.



#### Achieve clarity Iteration after itera-

tion, the algorithm adds smaller and smaller shapes, always seeking sparsity. Eventually it creates an image that will almost certainly be á near-perfect facsimile of a hi-res one.

cent of it when you compress, why not just save battery power and memory and record 90 percent less data in the first place? For digitals napabots of your kids, battery waste may not matter much, you just plug in and recharge. "But when the battery is orbiting jupiter," Candes says, "its a different story." Ditto if you want your camera to snap a photo with a trillion pixels instead of a few million.

The ability to gather meaningful data from tiny samples of information is also enticing to the military: Enemy communications, for instance, can hop from frequency to frequency. No existing hardware is fast enough to scan the full range. But the adverse

that reconstruct the original image more and more faithfully from the stored data.

That's the future. Today, CS is already rewriting the way we exputure medical information. A team at the University of Wisconsin, with participation from GE Healthcare, is combining CS with technologies called HYPR and VIPR to speed up certain kinds of magnetic resonance scans, in some cases by a factor of several thousand. (I'm on the university's faculty but have no connection to this particular research.) GE Healthcare is also experimenting with a novel protocol that promises to use CS to wastly improve observations of the meta-

# THE MILITARY COULD USE COMPRESSED SENSING TO HELP DISTINGUISH ENEMY CHATTER FROM RADIO STATIC.

sary's signal, wherever it is, is sparse—built up from simple signals in some relatively timy but unknown portion of the frequency band. That means CS could be used to distinguish enemy chatter on a random band from crackle. Not surprisingly, Darpa, the Defense Department's research arm, is funding CS research.

Compressed sensing isn't useful just for solving today's technological problems; the technique will help us in the future as we struggle with how to treat the vast amounts of information we have in storage. The world produces untold petabytes of data every day-data that we'd like to see packed away securely, efficiently, and retrievably. At present, most of our audiovisual info is stored in sophisticated compression formats. If, or when, the format becomes obsolete, you've got a painful conversion project on your hands, But in the CS future, Candès believes. we'll record just 20 percent of the pixels in certain images, like expensive-to-capture infrared shots of astronomical phenomena. Because we're recording so much less data to begin with, there will be no need to compress. And instead of steadily improving compression algorithms, we'll have steadily improving decompression algorithms

bolic dynamics of cancer patients. Meanwhile, the CS-enabled MRI machines at Packard can record images up to three times as quickly as conventional scanners.

And that was just enough for 2-year-old Bryce. Vasanawala, in the control room, gave the signal; the anesthesiologist delivered a slug of sedative to the boy and turned off his ventilator. His breathing immediately stopped. Vasanawala started the scan while the anesthesiologist monitored Bryce's heart rate and blood oxygenation level. Forty seconds later, the scan was done and Bryce had suffered no appreciable oxygen loss. Later that day, the CS algorithm was able to produce a sharp image from the brief scan, good enough for Vasanawala to see the blockages in both bile ducts. An interventional radiologist snaked a wire into each duct, gently clearing the blockages and installing tiny tubes that allowed the bile to drain properly. And with that-a bit of math and a bit of medicine-Bryce's lab test results headed back to normal. U 

JORDAN ELLENBERG (ellenber@math .wisc.edu), an associate professor of mathematics at the University of Wisconsin, wrote about the Netflix Prize in issue 16.03.

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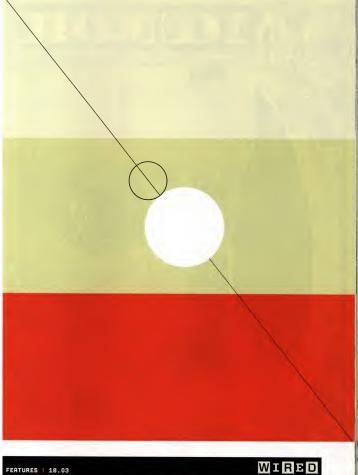
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# A SIMPLE TYPO GAVE MICHAEL IVEY THE IDEA FOR HIS COMPANY

One day in the fall of 2008, Ivey's wife, using her pink RAZR phone, sent him a note via Twitter. But instead of typing the letter d at the beginning of the tweet-which would have sent the note as a direct message, a private note just for Ivey—she hit p. It could have been an embarrassing snafu, but instead it sparked a brainstorm. That's how you should pay people, Ivey publicly replied. Ivey's friends quickly jumped into the conversation, enthusiastically endorsing the idea. Ivey, a computer programmer based in Alabama, began wondering if he and his wife hadn't hit on something: What if people could transfer money over Twitter for next to nothing, simply by typing a username and a dollar amount? ¶ Just a decade ago, the idea of moving money that quickly and cheaply would have been ridiculous. Checks took ages to clear. Transferring money from one bank account to another could take days, as banks leisurely handed off funds, levying fees nearly every step of the way. Credit cards made it a little easier to pass money to a friend-provided that friend owned a credit card reader and didn't mind paying a few percentage points in fees or waiting a couple of days for the payment to process. Ivey got around that problem by using PayPal. Since 1998, PayPal had enabled people to transfer money to each other instantly. For the most part, its powers were confined to eBay, the online auction company that purchased PayPal in 2002. But last summer, PayPal began giving a small group of developers access to its code, allowing them to work with its super-sophisticated transaction framework. Ivey immediately used it to link users' Twitter accounts to their PayPal accounts, and his new company, Twitpay, took off. Today, the service has almost 15,000 users. That may not sound like much, but it sends a message: Moving money, once a function managed only by the biggest companies in the world, is now a feature available to any

code Jockey. Ivey is just one of hundreds of engineers and entrepreneurs who are attacking the payment ecosystem, seeding out ways small and large to tear down the stronghold the banks and credit card companies have built. Square, a new company founded by Twitter cocreator Jack Dorsey, lets anyone accept physical credit card payments through a smartphone or computer by pluging in a free sugar-cube-sized device—no expensive card reader required. A startup called Obsopa, which has received funding from Nokia, allows shone

Money Over Time
A brief history of
currency technology.
—BRYAN GARDINER



transfer money to one another with nothing more than a PIN, Amazon, com and Google are both distributing their shopping cart technologies across the Internet, letting even the lowliest etailers process credit cards for less than the old price, cutting out middlemen, and figuring out ways to bundle payments to sidestep the credit card companies' constant nickel-and-diming. Facebook appears to be building its own payment system for virtual goods purchased on its social network and on external sites. And last March, Apple gave iTunes developers the ability to charge subscription fees through their applications, making iTunes the gateway for an entirely new breed of transaction. When Research in Motion announced a similar initiative last fall at a session of the BlackBerry Developer Conference in San Francisco. programmers crowded the room, spilling out into the hallway. About 20 percent of all online transactions now take place over so-called alternative payment systems. according to consulting firm Javelin Strategy and Research. It expects that number to grow to nearly 30 percent in just three years.

But perhaps nobody is as ambitious as PayPal. In November, it further opened up its code, giving anyone with rudimentary programming skills access to the kind of technology and payment-industry experience that Ivey used to build Twitpay. The move could unleash a wave of innovation unlike any we've seen since self-publishing came to the Web. Two months after Pay-Pal opened its platform, 15,000 developers had used it to create new payment services, sending \$15 million through the company's pipes. Software developer Big in Japan, whose ShopSavvy program lets people find an item's cheapest price by scanning its barcode, used PayPal to add a "quick pay" button to its app. LiveOps, a call-center outsourcing firm, built a tool that streamlined payments to its operators, turning what had been a nightmare of invoicing and time-tracking into an automated process. Previously, anybody who wanted to create a service like this would have had to navigate a morass of state and federal regulations and licensing bodies. But now engineers can focus on building applications, while leaving the regulatory and risk-management issues to PayPal, "I can focus on the social side of the business and not on touching money," as Ivey puts it.

PayPal is just the latest company to try to harness the creative powers of the open Internet. Google created a platform that lets anyone buy or display online advertisements. Racebook allows any developer to write applications for its social network, and Apple does the same with its Trunes App

Store. Amazon's Web Services provides developers the cloud-based processing power and storage space they need to build applications and services. Now PayPal has brought this same spirit of innovation and experimentation to the world of payments. Your wallet may never be the same.

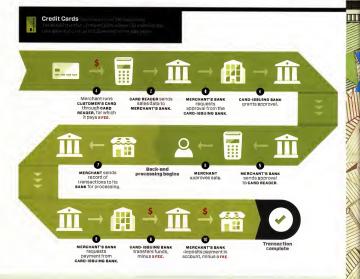
THE BANKS AND CREDIT CARD COMPANIES have spent 50 years building a proprietary, locked-down system that handles roughly \$2 trillion in credit card transactions and another \$1.3 trillion in debit card transactions every year. Until recently, vendors had little choice but to participate in this system, even though—like a medieval toll road—it is long and bumpy and full of intermediaries eager to take their crut. Take the common swipe. When a retailer initiates a transac-



# 9000 BC: Cows

The rise of agriculture made commodities like cattle and grain ideal proto-currencies: Since everyone knew what a helifer or a bushel was worth, the system was more efficient than barter.

# 3 WAYS TO MOVE MONEY Credit cards are expensive and inefficient, iTunes and PayPal streamline the transaction process, —B.G.



tion, the store's point-of-sale system provider—the company that leases out the industrial-gray card reader to the merchant for a monthly fee—registers the sale price and passes the information on to the store's bank. The bank records its fee and passes on the purchase information to the credit card company. The credit card company ben takes its share, authorizes all the previous fees, and sends the information to the buyer's bank, which routes the remaining balance back to the store. All in all, it alkes between 24 and 72 hours for the vendor to get any money, and along the way up to 3.5 prevent of the sale has been shiphoned away.

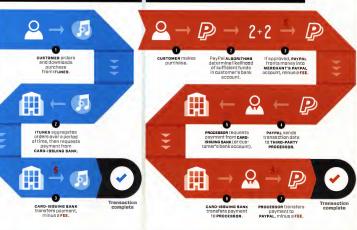
In the earliest days of credit cards, those fees paid for an important service. Until the late 1950s, each card was usually tied to a single bank or merchant, limiting its usefulness and resulting in a walletload of unique cards. But when BankAmericard—later renamed Visa—offered to spitl its fees with other banks, those banks began to offer Visa cards to their customers, and merchants began accepting Visa as a way to drive sales. Meanwhile, Visa and rival MasterCard—as well as distant competitors American Excress and Discover—used their shave of the frees to huild

their own global technological infrastructures, pipes that connected all the various banks and businesses to ensure speedy data transmission. For its time, it was a technologically impressive system that, for a price, brought ease and convenience to millions of buvers and sellers.

But today, vendors are seeing fewer benefits from paying those fees, even as credit card companies have jacked them up over the years. Credit cards were once a way for a business to differentiate itself from competitors, but now that they've grown ubiquitous, nearly all vendors must accept them or risk losing a huge swath of customers. According to a 2003 study in the Review of Network Economics, every sale by credit card costs a merchant six times what the same sale with cash would run. Cdsat, comes with its own







costs, such as requiring more oversight of cashiers, upkeep of vaults, and a bank's services to process it.) Not that the store owner is ever quite sure how much

a credit card transaction will cost. MasterCard and Visa charge hundreds of different rates—called interchange fees—for every type of card that runs through their networks; mileage cards tend to charge higher fees, for example. And if a retailer accepts one flawor of Visa, say, if has to accept them all, no matter the fee. In 1991, MasterCard had four fees, the highest of which had an interchange rate of 2.08 percent. Today it has 243 fees, and the heftiest one tops out at over 3 percent—more than a 50 percent jump. And yet the service provided has hardly grown any better, faster, or easier to access. "It seems really odd that credit card companies can

continue to charge a tax on the economy, "says Aaron Patzer, founder of the inancial management service Mint.com, which is now owned by Intuit. "Outside the US government, they are the only entity that has the power to levy a fee across virtually every transaction. Maybe that made sense in the early 1960s, when computer infrastructure was expensive and proprietary. But now, with cheap bits everywhere, the actual cost to do a transaction is pennies."

There is, in other words, a massive inefficiency to be exploited. And so, an army of engineers and entrepreneurs is rushing in, hoping to do to the pay-



### 1200 BC: Shells

Rare or exotic items like shells, whale teeth, and metals were used for trade by cultures around the world because their scarcity and beauty lent them great symbolic velue. (The earliest Chinese character for money was even a cowry shell.)

ment world what has already been done to the music, movie, and publishing businesses-unseat a legacy industry built on access and distribution, drive the costs to zero, undercut the traditional middlemen, and unleash a wave of innovation. Square's Dorsey sees his company as creating a new, open system that allows users to swap funds instantly, without a series of interlopers grabbing their share. "We bring an engineering discipline to this problem," he says, "What we want to know is, how can we get right to the source?"

For businesses that depend on moving money, the distributed, lower-cost, easier-to-access future can't come soon enough. Mitchell Wolfe, an ecommerce veteran who ran Compag's Canadian Internet sales team before moving on to a series of startups, has been wrestling with the payment industry for 15 years. "There's friction all over the place," he says. He once helped build an ecommerce system for a Persian rug vendor and was stunned to find that the rug dealer's bank required it to keep \$250,000 in its account in case a charge was disputed. The lesson stuck. When he started bTrendie, a members-only site that sells clothes and gear for pregnant women and new mothers, he decided to do as much as possible through PayPal. Now he accepts payments from customers into the same PayPal account he uses to pay his vendors. The money flows instantly, bypassing direct contact with banks or credit cards. That means no charges for moving money internationally, no extra staffers, no long delays while he waits for transactions to process, and he can keep better track of his cash and data. For Wolfe, the old payment world is a vestigial appendage. "The less you have to deal directly with the banks and credit card companies," he says, "the better off you are,"

# THIS



## 640 BC: Coins Historians credit

the Lydians of Asia Minor (now Turkey) with developing the first coins. Made of electrum-an amaloam of cold and silver-the innovation was promptly adopted by the Greeks, sparking a commercial revolution in the sixth century BC.

THE KIND OF revolutionary fervor that PayPal was always intended to foment, Peter Thiel, PayPal's cofounder and a die-hard libertarian, launched the company as a means of creating a stateless monetary system, making it possible for anyone to switch, instantly and easily, between global currencies. "PayPal will give citizens worldwide more direct control over their currencies than they've ever had before," he told new employees in 1999, according to the book The PayPal Wars.

this international network of workstations. "It will be nearly impossible for corrupt governments to steal wealth from their people," But for most of its history, PayPal acted more as an enabler—a way of extending the credit card model of payment into the online realm—than as a bomb-thrower. Customers didn't want to use PayPal to escape the tyranny of government currencies. They wanted to use it

to spend money online without having to give out their credit card information to a million

different vendors. By the turn of the millennium, PayPal pretty much operated as an online

credit card company, charging vendors a percentage of every transaction to move funds

from a buyer's bank account to a seller's bank account. Still, there were some hints of Pay-

Pal's revolutionary capabilities. Unlike credit card companies, PayPal had no need to build and maintain an expensive digital network between vendors and banks around the world: it operated over the Internet. There was no need for a credit card reader, cutting point-of-

# The New Ways to Pay

The credit card is in decline. Here are a few hints of what might replace it. - p.s.

### Twitpay

Type a friend's Twitter handle, a dollar amount, and twitpay to transfer funds to their PayPal account.

### Zong

Instead of entering credit card information anew for every online purchase, users fill in their phone number and the charge shows up on their monthly bill.

### Square

The latest from Twitter cofounder Jack Dorsey, this 3/4-inch cube turns any iPhone into a credit card reader.

# GetGivina

This mobile appuses PayPal to enable charities to accept small donations without the usual exorbitant credit card transaction fees

### **Hub Culture**

Travelers can avoid the hassle and fees of swapping dollars for euros by transacting in virtual currency in

sale system providers—and their vigorish—out of the equation. While credit card companies still paid fees to banks, a legacy from the days when they had to buy their cooperation, PayPal piggybacked on a commu-Ш nications system that enables digital transactions like direct deposits and automatic bill payment without charging a fee, Furthermore, PayPal users could keep their funds within their PayPal accounts, accruing interest and continuing to trade them with other Pay-Pal users without ever once involving banks or anyone outside the PayPal ecosystem-a friction-free shadow

economy in its own right. All of these advantages meant that PayPal could charge lower transaction fees than traditional credit card companies. That may have been a good business model, but it wasn't exactly a game changer.

In recent years, many other companies have come up with their own PayPal-like innovations. creative tweaks to further squeeze some margins out of the traditional credit card model. Apple's iTunes and Research in Motion's payments program reduce transaction fees by bundling a cus-

> tomer's purchases before sending them to a credit card company for processing, (That's why you don't usually see a series of 99-cent charges on your credit card bill: they are processed as one lump sum.) Virtual currencies. from Microsoft Points to Linden Dollars, encourage



AD 800: Paper A shortage of

copper and the hassles of transporting heavy coins prompted China's Tang dynasty to start issuing paper notes, Dubbed "flying cash," this first paper-based money was used by merchants and the government.

"in-world" trade, incurring credit card and banking fees only when their users buy in. By reducing their exposure to traditional transaction systems, these companies are able to wring extra pennies of profit out of each sale—which can aggregate into millions of dollars, turning their payment platforms into profit generators in their own right.

PayPal moved even further away from its revolutionary roots in 2002, when it was purchased by eBay for \$1.5 billion. Suddenly the service, always a favored payment method on the site, became almost entirely focused on making auctions easier, Between 2005 and 2008, PayPal went from serving as the payment provider for 47 percent of eBay auctions to facilitating more than 60 percent (eBay expects it to hit around 75 percent by 2011). That was a fine strategy as long as eBay was growing. But in CEO Meg Whitman's last years at the company's helm, as the auction platform started to see a slowdown in revenue growth, it became clear to the PayPal team that it was time to get aggressive again. PayPal started working with outside vendors, and by 2007 it was transacting \$47 billion worth of business a year-still a pittance compared to the trillions that moved through financial institutions. Scott Thompson, then PayPal's CTO, started meeting with Osama Bedier, vice president of merchant services technology, and his team. How, Thompson asked, could PayPal capture more of that business?

Bedier's team argued that PayPal's users seemed to have plenty of ideas. They had long pushed for Pay-Pal to expand into new businesses-payroll, invoicing, business-to-business money transfers. But building out any one of those services would take years, and the timing wasn't right. Bedier pointed out that PayPal's



users had been responsible for many of the company's most successful innovations: Users dragged PayPal onto eBay in the first place. (The company had initially resisted the move.) Other users cobbled together PayPalenabled "tip jars," which quickly spread across the blogosphere. What if the company opened upits code, embraced its developers, and turned its service into a platform? What if PayPal asked its users to create the tools and functions that would make it prov/

Thompson loved the idea in theory but was skeptical that Bedier's team could pull it off. Thompson, who had recently left Visa, was hardly used to Silicon Valley's freewheeling, experimental culture. With his Boston accent, bushy Cliff Clavin mustache, and fondness for pleated pants and button-down shirts, holoked like a dotcom engineer's straight-laced father. "Where I come from, you can't just let developers come in here and open accounts and move money around." he saws.

Bedier was used to blasting through objections. Born in Cairo, he had spar a few years in Oregon as a preteen while his father earned a PhD. When the family moved back to Egypt, Bedier put together a plan to return to the Us. He persuaded his father have a friend, an TT manager at Oregon State University, take legal guardianship. Bedier never left the States again. Now he turned his powers of persuasion on Thompson. He said he would prove he could make a more one new system work.

But first he had to figure out whether developers would play along. So in late 2007, he started on a road trip to meet with the people who were already building on PayPal's limited open code. He met with more than 100 developers, most of whom were eager to help build an easier, more flexible system. PayPal had been requiring

buyers and sellers to go through several steps to complete a transaction go to its site, fill out forms, authenticate accounts. The developers envisioned something larger, a true digital currency that could be used on any Web site, that enabled money to move as easily as email: Send funds with a click, from and to anywhere and anyone on the Net.

In April 2008, Bedier led a meeting at eBuy's North First Street headquarters, where he presented his idea to GEO John Donahoe and his lieutenants. When Bedier was finished, he was stunned to get applause. "It was like a lightbulb clicked on," Donahoe says. "I basically said, You have unlimited funding." This is the highest-potential business I've veer seem in my career."

Bedier hired executives from the banking and airline industries to help him design the platform. Soon other PayPal engineers were asking to be transferred

to the project. They saw it as a return to PayPal's original ambitions, when Peter Thiel and his cofounder Max Levchin sought to create an entirely new currency—not just a tool to help people sell used roller skates to one another. (In homes to this legac, Bedier's team called the project X.com, the name of Blon Musik's payment company, which PayPalmergad with back in 2000). In November 2009, PayPalmergad with back in 2000, In November 2009, PayPalmergad with back in 2000 in Returne that should have terrified the traditional payment conglomerates: a new fee structure that charged vendors about one-third of what credit card comanies were charging.

# WHATEVER THE FUTURE

DE PAYMENTS looks like, it will probably be brought about by pepie like Christian Lanng. A tall and wide 31-year-old with aboming, operatic voice, Lanng Is sitting on the couch of his venture backer's house in Copenhagen. When he talks about the way banks and credit card companies process payments, he gets so upset that his entire body tenses and his voice rises until it's echoing off the stark white walls. "This is the main battleground of capitalism" he save, "This is the heart off it."

Lanng rests his MacBook on a tree-stump table infront of him. For the last seven months, he and a dozen or so other coders have been building ane-invoicing company called Forta. Act press time, Lanng was planning to rename the company TradeShift. Already, the service has signed up two regions innorthern Burope and one of the biggest cities in Brazil, but Lanng envisions something much bigger. He sees dynamic invoices that pay themselves—that constantly monitor exchange rates, say, or the price of lumber, and then automatically send out an order to withdraw funds or to make a purchase just when the price is cheapest. Most of the luftormation is already

available—there are plenty of databases that provide realtime pricing information, and he already has all of his cilents' account information and vital data. But Porta doesn't have the technology or expertise to handle the transactions themselves. That's why Lanng is coding with X.com.

For now, PayPal has shied away from using revolutionary rhetoric. In discussing its role, company executives sound less like Thiel, bent on overthrowing the system, and more like awould-be thief strolling through a jewelry store, determined to appear nonthreatening. ("We're not an alternative to credit cards. We use credit cards in the PayPa wallet!" Donnbee says. "That's part of the beauty of PayPal.") And consumers, who have traditionally been shielded from credit card companies' vendor fees and practices, may not care, or even notice, whether vendors use PayPal.

But even if PayPal never fires a shot, it is clear that people are looking for an alternative to credit cards. In 2009, US consumer credit card debt saw a sustained drop for the first time in decades, fall-

ing for 10 straight months as the recession took hold. Meanwhile, to fee-socked consumers struggling to make their payments, the credit card companies have become symbols of an uncaring, greedy bureaureray. "As a longtime participant in the credit card industry, I'm interested to watch what's going on right now, because credit card companies are actually yanking in credit, they're raising fees, and people are choosing not to use credit cards." says a Sack Stephen-



### 1949: Plastic When the check

When the check for dinner arrived, Frank McNamars realized he didn't have enough cash to pay his bill. When the world needed, he realized, was an alternative to currency. One year later he returned to the same restaurant with what would become the first modern credit card, the Diners Club Card.



# 1995: Digital

Cryptographer David Chaum wented consumers to be able to transfer money digitally, just like banks. His ecash was an anonymous form of money first issued by an American bank in 1995. The company declared bankruptcy in 1998, but the concept has since been built upon by dozens of digital and virtual currencies.

son, PayPal's head of strategy. "And the attitude a lot of people have about their credit card company is not a warm and fuzzy feeling right now. So I don't think, at least anytime in the next three to five years, that PayPal needs to do anything to convince people not to use credit cards online. I think people will make that choice on their own."

A generation ago, when people made the choice to switch to plastic, credit cards did not just replicate eash; they fundamentally changed how we used money. The ease with which people could make purchases encouraged them to buy much more than they had in the past. Entrepreneurs suddenly had access to easy—though high-interest—loans, providing a spark to the economy. Now, while it may be hard to predict what timovations PayPatPs justform will enable, it's safe to say that the payment industry is going to change dramatically. As morey becomes completely digitized, infinitely transferable, and friction-free, it will again revolutionize how we thinkabout our economy. [III]

DANIEL ROTH (dr@danielroth.net) wrote about Oracle in issue 18.01.



AT FIRST GLANCE, things seem to be going | rather badly for Revin 8 mith. The actor. screenwriter, and director scored a critical success with Clerks during the indie film boom of the 1990s, but he's never been able to repeat the feat. Several efforts to reinvent himself-like the romantic comedy Jersey Girl and the bromantic comedy Zack and Miri Make a Porno-tanked. With his latest film (Cop Out, due at the end of February), he's directing someone else's screenplay for the first time-a stretch for a guy who admits that he's not much of a visual stylist. But if Smith's film career is sputtering, his career as an off-color online raconteur is booming. He has a popular podcast and Twitter feed and a well-trafficked Web site with a lucrative merchandise portal. And he has parlayed that online celebrity into a best-selling book and a successful speaking tour. We talked to Smith about his two-pronged career.

# Your films are known for gross-out humor and scatological debates. I say what other people won't. I don't have

any fancy special effects. Or any discernible talent. That filthy dialog is my only shtick. Tommy Lee has a huge cock; I've got this.

# Tommy Lee has a huge cock; I've got this And yet the tone of your movies is also casual and intimate.

My cinematic method is oversharing, I didn't get into film to win Academy Awards. I wanted to have a conversation with the audience. Clerks was an icebreaker—a way to say, "Hi, my name is Kevin Smith and I Would love to talk to you for the next 50 years."

And now the kind of TMI conversations your characters have is the norm in chat rooms, and your brand of

humor is everywhere in viral videos.
I was speaking the language of an Internet
audience that didn't exist yet, Wi 1995 movie,
Mallrats, centered on comic book nerds. Who
wants to see comic book nerds in a movie? The
sort of geeks who trade Monty Python tapes.
That picture was your first bomb.

I can't tell you how miserable that made me. But now 15-year-olds who were just some-body's dirty urge when the film came out gush to me how much they love Mallrats. And the Web made that possible? Before that, the only way filmmakers knew

what audiences thought was from critics' reviews. Suddenly, we had a conduit. If there was no Internet, my career would have ended in 1995. Now I bet that everyone who hates my movies is thinking, "Fuck! I need to find a flux capacitor and go back in time to destroy the Internet!"

But it seems like other filmmakers are now having greater success with the kind of humor you established. My movies never made much more than \$30 million; Judd Apatowshattered that glass ceiling. Suddenly, my type of humor, the talky R-rated bromantic comedy, was in vogue. Yet your last film, Zack and Miri

Make a Porno, was widely viewed as an attempt to emulate Apatow.

I thought I could make a Judd movie. I even got Judd's boy, Seth Rogen, to star in it. And, uh, it was another bomb.

Yeah. That one really hit me hard. It wasn't the money. What bugged me most was that I realized I couldn't just keep reaching into my chest, pulling out chunks of my heart, and slapping them on a platter.

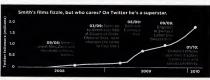
But online, you can do just that, right? You seem to have amped up your Web presence since that movie.

Oh, Tm online all the time now. Tmn ot a nout-doorsy type. Everything I do that's not related to fillmmaking or child-rearing or trying to fuck my wife is online. The medium of Twitter is built for me. I recently did a 24-hour tweetathon, and people asked me how I did it. I said, "The only difference between this and my normal regimen is that I tely ou know I was doing it." I have I. 6 million followers—this army of people who think like me. There aren't enough of us to invade a whole country, but we could probably take Quebec.

They're numerous enough to put a book-length collection of your blog posts on best-seller lists and fill auditoriums to see you talk about whatever pops into your head.

Yeah, Iused Twitter to sell out Carnegie Hall, My dream is to never have to take a real job again. If my next movie bombs and nobody ever gives me another dollar to make more, twouldn't care. I don't need tool anymore. I was never convinced that the film thing would last anyway. It just made me interesting enough to have a Web site. <sup>1</sup>

Contributor ERIN BIBA (twitter.com /erinbiba) wrote about brewing beer from 45 million-year-old yeast in issue 17.08.





# by Gary Wolf



A simple INBRED RODENT became one of the most important—AND FLAWED—subjects in the history of science. Next up for the lab mouse: HELPING TO REPROGRAM the human genome.



In 1957, a new medicine appeared on the market. Thalidomide was an effective sedative, but it was also promising as a treatment for pregnant women because it quelled nausea and vomiting. And scientists had great confidence in thalidomide's safety. It had been tested extensively on mice and found to be nontoxic. It was so harmless, in fact, that no lethal dose could be established. ¶But thalidomide was withdrawn from the market after only a few years, by which time its name had become a byword for the horrible consequences of placing too much faith in the similarities between mice and men. Although nontoxic in rodents, thalidomide caused human limbs to stop growing prematurely in utero, resulting in the birth of babies with malformed arms and legs. It took decades for the science behind this medical catastrophe to be fully understood: The shape of the thalidomide molecule fits neatly into a stretch of human DNA that controls the formation of new blood vessels during a few short weeks of embryonic development. Before this time, thalidomide has no effect. After these weeks,



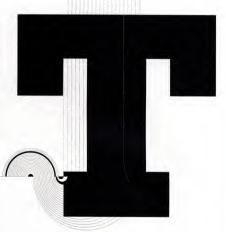
it is equally safe. During the years of its use, from 5,000 to 10,000 children around the world suffered severe birth defects.

The history of using mice to stand in for humans in medical experiments is replete with failures. The case of thalidomide is only the most notorious. Cancer, cardiovascular disease, diabetes, Down syndrome-mice that express some version of each of these conditions sit at the foundation of multiple lines of research, all of which have had major setbacks. The reason became clear over decades of fervent and often fruitless science: Mouse metabolism is not human metabolism, so mouse-based diabetes and cardiovascular studies may be fatally flawed. Mouse cancers are not human cancers, so oncology models can be misleading. Mouse Down syndrome is not human Down syndrome, so conclusions drawn about the disorder may be wrong.

Barely 10 years ago, somebody who took a quick glance at the history of the mouse in science might reasonably surmise that the story was reaching its end. "There is no question about it: The number of animals used in laboratory experiments is going down," a Scientific American article concluded in 1997. But this analysis was incorrect. Instead, the opposite happened. In the decade that followed, the lab mouse had a sudden and dramatic resurgence that continues today.

Last year, the Jackson Laboratory, historically the most important supplier of lab animals to science, sold more than 2.7 million specimens, up from 1.9 million a decade earlier, Jackson's major competitor in the mouse business, an operation known as Charles River Laboratories International, sold more than \$660 million worth of rodents and related services in 2008, up from \$405 million in 2003.

What happened? The answer is that the mouse changed. Our dilaboratory mice had been bred to resemble us in interesting ways, to suffer familiar diseases like diabetes or cancer, or to achieve impressive goals, like extreme longevity. They were model animals in the sense that they were used as substitute people, miniature humans that were both wersatile and morally expendable. The new mouse is a model in a different way—not a tiny stand—in for a human but a kind of exemplar. We are using it to explore the limits of biological systems, sending it into a future where flesh is blended with took under the mouse of the subset of the limits of the where flesh is blended with took.



The archetype of the laboratory mouse was invented early in the last century by an undergraduate at Harvard. For three years, starting in 1909, C. C. Little, a former college track star whose father had bred dogs, mated generation after generation of mouse siblings. The word genetics had been coined only a few years earlier, and many researchers were trying to find out whether the laws of inheritance discovered by Gregor Mendel through experiments on peas in the mid-1800s could be replicated and extended with other species. The structure of the DNA molecule wouldn't be known until 1953, and figuring out how to sequence genes would take still more decades; early geneticists were working in the dark. They inferred things about the genome by mating animals and hybridizing plants, looking for patterns and ratios in the traits that were inherited. To reduce the complexity of their experiments, they often bred close relatives. This allowed them to stabilize a genome, fixing traits through generations. Fruit flies, an early favorite of geneticists, could be inbred easily. But in mammals, each incestuous generation was weaker than the last.

Little's approach to the problems caused by inbreeding was straightforward: He simply used more mice. The healthiest offspring of each generation were the progenitors of the next; weak individuals were culled. In three years of experiments, Little reared more than 10,000 mice. By 1913 he had a healthy, genetically stable inbred strain. He could then choose a characteristic—pinkeyes, say, or a brown coat—and produce an endless supply of animals, each as alike as twins or clones. Some researcher sturned to guinea pigs or rats to explore the workings of mammalian genetics. But for Little, mice turned out to be a lucky choice. They were small, docile, and cheap to feed. And for reasons that wouldn't become clear until much later, they were easier to manipulate genetically than other rodents. But there was one special feature that sealed the success of the mouse over all its competitors in labs around the world: The mouse got cancer. When Little started his work, it had already been observed that many mouse tumors are similar to human ones. And if you took a portion of a mailignant tumor from one mouse and transplanted it to others, so metimes the mice with the transplants would get cancer, too. Was cancer an inherited condition?
Was it an infectious disease? These questions had been debated for at least 20 years before Little made his mice. But

at the turn of the century, a single tumorous mouse cost hundreds of dollars, making it prohibitively expensive to run experiments. Little's success with inbreeding promised to drive the price way down. If pink eyes could be stabilized in an inbred strain, why not susceptibility to cancer? Little offered a cheap supply of thry patients to try things out on.

In 1919, a bacterial infection swept through Little's colony, killing all his mice. But news of his success had encouraged other geneticists, who continued to mate brother and sister, mother and son, searching the genetic landscape for useful variants. Little's mice, and those of his collaborators, are the direct procenitors of rodents still being used today.

Little, meanwhile, was a prodigy. In 1922, at age 32, the took a job as president of the University of Maine, becoming the youngest college chief in the US. Maine was where many of the top executives of the new Detroit auto-companies likedrospend their summers; Little socialized frequently with the elite vacationers, and in 1925 his Detroit friends haved him to Ann Arbor to become president of the University of Michigan. It didn't go well: Little favored eugenics, women's rights, and access to birth control; his marriage fell apart; and he tried to restrict undergraduates from both owning cars and drinking alcohol.

Soon Little was out of a job. But his reforms to zeal appealed to the utopian industrialists of Middle America. The pioneers of the auto industry were as confident about their ability to remake society as Google executives are today; their assembly lines were a source not only of new fortunes but of new technocratic ideals. In 1929, they are left the University of Michigan, Little went to the industrialists with a plan to influence human life on a vast scale. Little had been serving as president of the American Eugenics Society. In the decades between the two world wars, eugenics was respectable; its mixture of racism, social Darwinism, and the emerging science of genetics had not yet been discredited by better science, civil rights, and revulsion at Nazi racial cleansing. Little envisioned the inbred mouse as a link between taboratory



scientific community. He and his fellow "mousers" were highly influential among the review boards of national institutes, and they encouraged health researchers to use mouse models. Little also took his case to the public, which wanted to see cancer cured, ceaselessly pushing the idea that valid cancer research required experiments using standardized mice.

This created a complex feed-back loop that mixed scientific prestige, financial reward, and big promises of a cure for cancer. Of course, Little's colleagues and successors were doing brilliant basic science. They played key roles in the discovery of retroviral oncogenes, the development of techniques to map the genome and connect genes to

C. C. Little invented the modern lab mouse in 1909. His goal was to create the perfect platform for scientific experimentation.

science and the ideals of eugenics. An auto industry magnate named Roscoe B. Jackson decided to support his dream. When Jackson died suddenly, his family and Little's other patrons provided the seed capital for Little to move back to Maine and establish his own independent laboratory, "Many if not all of our major ills of today are dependent on the fact that we have not used our intellect in the making of men as we have in the production of machinery," Little wrote a few years after launching the lab. His tiny inbred "machines" would show what kind of control could be achieved over the evolution of a species when the effects of breeding were understood in detail.

Still, Little did not immediately become the Henry Ford of mousedom. His facility, called the Roscoe B. Jackson Memorial Laboratory in honor of his deceased patron, suffered severe financial stress during the Depression. In her book, Making Mice: Standardizing Animals for American Biomedical Research, 1900–1955, Karen Rader recounts the early history of the Jackson Laboratory and how Little engineered its survival by creating a market for inbred mice in the

traits, and the chemistry of the immune system. More than 20 Nobel Prizes would eventually be linked either to people who worked at the Jackson Laboratory or to the inbred mice invented there. But in time a problem emerged: The stated goal of all this science –curing cancer—proved intractable. While the mouse led scientists deeper and deeper into the complexities of the genome, many basic clinical questions went unanswered. In fact, up until the mid-1980s, most of the advances that have been made against dissess—clean water, good nutrition, vaccinations, arithiotics—were barely influenced by Jackson Lab's mice.

Among the sharpest ironies in Little's later career is that although the grand public health projects that drove the research bureaucracy failed to deliver, his original engenies program succeeded—with mice. While social eugenics never managed to produce an ideal human, the perfect control exercised by the mousers over the breeding of their model animal allowed them to deliver subjects that had an enormous range of customized traits. Fat ones, thin ones, blind ones, deaf ones: I CONTINUES ON ARGE 123

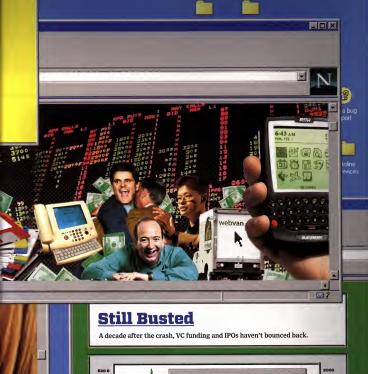
# The Dotcom Boom, 10 Years After

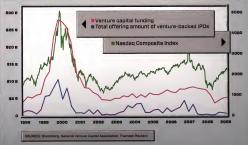


On March 10, 2000, the Nasdaq peaked at 5,048.62. Then it promptly nose-dived, never to see that level again. Here's a look back at the era that launched—and crushed—a million dreams.

by Mathew Honan and Steven Leckart







# **Where Are They Now?**

Catching up with some key inflaters of the technology bubble.



Stephan Paternot THEN Founder.

TheGlobe.com KNOWN FOR Netting tens of millions of dollars when the anline community he started in college produced the largest IPO in history; quitting a year later efter the stock fell precipitously. ARE AT IPO 24 NOW Angel investing; producing films like Life 2.0, a doc ebout Second Life.



Fanning

THEN Inventor. Nanster KNOWN FOR Singlehandedly sparking the file-sharing revolution from his dorm room and dragging the music business into the digital era. COST OF SETTLING **BIAA LAWSUITS** \$26 million NOW Starting a new, mysterious company with Facebook



Ebbers

THEN Founder. WorldCom KNOWN FOR Being convicted of conspiracy and fraud after bilking investors out of \$11 billion. BEFORE PLEADING THE FIFTH "I believe that no one will conclude that I engaged in any criminal or fraudulent conduct." He later pleaded guilty. NOW Ooing 25 years



Meeker

THEN Analyst. Morgan Stanley KNOWN FOR HERing her benk to take Netscape public, launching the dotcom boom: being bullieh on location-based mobile services NOW Still a Morgan Stanley analyst. Meeker's annual talk at the Web 2.0 Summit is required viewing for today's more sober investors.



Shaheen

THEN CEO, Webvan KNOWN FOR Leaving the ton inh at Andersen Consulting to lead an online grocery startup; reising \$400 million from VCs and then \$375 million In an IPO; quitting before Webvan filed for bankruptcy. VALUE OF GOLDEN PARACHUTE \$375.000 a year NOW Sits on several company boards.



Frank Quattrone THEN Investment hanker Credit

Suisse First Boston KNOWN FOR Urging employees to "clean up" files that proved CSFB got kickbacks for slipping hot etock to clients. MONTHS HE HAD TO REHAVE REEDDE HIS OBSTRUCTION OF JUSTICE CHARGE WAS DISMISSED BY A.IIIINGE 12 NOW Runs a merchant hank



Philip Kaplan

THEN Founder FuckedCompany.com KNOWN FOR RUDning a dotcom death pool that provided a daily shot of schadenfreude: turning the site's software into the successful online ad server AdBrito NOW His new yenture Blippy shares information about credit card purchases with your friends



alum Oave Morin.

### Josh Harris

THEN Founder, Jupiter Communications and Pseudo.com KNOWN FOR OUMPing millions into a pigneering but doomed webcasting site: lavish parties: Big Brother-ish art projects; holding client meetings dressed in drag. **NOW Appearing** in the doc We Live in Public. Trying to raise millions for another art project.



for nine felonies.

# Rhatia

THEN Cofounder. Hotmail KNOWN FOR Selling his company to Microsoft for \$400 million on hie 29th birthday. making a 1,333 percent profit off free Web-based NOW Hoping to re-create his formula for success with SabeeBolo, a free online telecon-

ferencing service.



# 2000 vs. 2010







Illustrations by Gluekit

Dutlook

Illustrations by Walbaum







Wired - March 2010





Napster.com (file-sharing) -> BestBuy's music-streaming service Pets.com (ecommerce) -> PetSmart online community Pointcast.com (push information delivery) -> Flash application librery Scient.com (strategic consulting) -> Domain squatter

> "We see Time Warner and AOL as the sort of classic one-plus-one-equals-three situation here."

--AOL president and CEO Robert Pittmen, January 2000 (Earlier this year, former Time Warner CEO Gerald Levin said the AOL acquisition was "the worst deal of the century, apparently.")

# Survivors

Docu

Services

These dotcom pioneers may lack



AltaVista The firet killer search engine is still processing queries-end reminding us agein why Google won.

The Knot More than a decade after its IPO, the Knot proves that even if marriage isn't always eternal, it'e still profitable.

Tripod

GeoCities razed

Web hosting in

The Industry Standard The dotcom bible starved to death on \$200 million a year. Now it publishes tech news online.

iVillage

The etock of

this women's

community site

dropped from \$114

to less than \$1 but

found a lifeline in

buyer NBC.

The Motley Fool Long after the bubble burst, this investment research haven is having the last

Lycos

Once a large

portal player and

now a search site

owned by a South

Korean company.

owner of Wired

com, Lycon in

\_ 🗆 ×

RedEnvelope A bankruptcy filing its online commuand a new owner nity, but the other mean this gift site go-to site for free can still help you find that perfect the '90s remains something for

Mother's Dev.

bar, but this

leugh

Salon The stock costs lese than a candy pioneering Internet magazine remains one of the Web's sweetest reads.





Window Help tions Directory



/magazine/10yearsafter

Handbook

Net Search

**Net Directory** 



# **Great Ideas, Bad Timing**

The dotcom collapse decimated lots of bad ideas. (Free one-hour ice cream delivery, anyone?) But many great concepts got trapped in the rubble. Here are some that have struggled back to life.

	M	
-	HIE	
- 42	A STATE	
	(10) A	
40	C- 400	
- 111	A PARTY OF THE PAR	

**Great Idea** FREE INTERNET ACCESS (NetZero. BlueLight)

FREE

Ad-supported dialup had its day, until Internet edvertising dried up and costs spiraled out of control just as consumers began flocking to broadband.

Jimmy Wales' first

Why It Failed

free or tiered access

Wi-Fi lets providers grant without investing a fortune on Infrastructure.

Why It's Succeeding Now Who's Behind the Rebirth

Merakl, municipal Wi-Fi



ONLINE ENCYCLOPEDIA (Nupedia)

encyclopedia venture relied on professionally edited. peer-reviewed writeups from expert sources. Read: time-consuming and costly.

Hey, check out all these monkeys! We should totally give them typewriters. Or at least let them edit this stuff themselves

Wikipedia (and ell the other Wiki'd-pedias out there)



THE INTERNET AS TV (Broadcest.com. RealAudio Player GoldPass)

Yahoo paid \$5.7 billion for Broadcast.com, but it died in the pipe. Internet video before broadband was like pouring ter through a garden hose.

YouTube built the bridge to the broadband era. while media execs eager to avoid the music industry's mistakes agreed to distribute content online.

Amazon.com, Boxee, Hulu, iTunes, Netflix, Vimeo, YouTube

soft

×



VIRTUAL CURRENCY (Beenz, Flooz) Consumers weren't thrilled with being paid by one site for actions they took on others, and regulatory hassles hurt virtual currency's prospects.

Let consumers spend virtual bread the same place they bake it: inside game worlds and on social networks.

AceBucks (Facebook). gold (World of Warcraft), Linden dollars (Second Life), Offerpal



PUSH INFORMATION DELIVERY (PointCast)

PCs with antediluvian vR6 processors, slow Internet connections, and pattry memory struggled to serve push applications.

Mobile devices, faster processors, and cheap RAM now push updates to us everywhere, all the time. Make It stop!

CNN mobile app, Fecebook. FriendFeed, iPhone push notifications, Pubsubhubub, RSS, Twitter

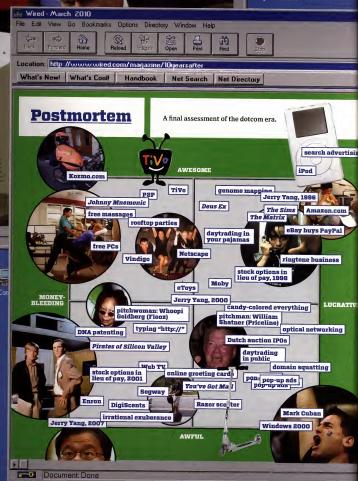
Error : Duplicity



Page 093



"It's a piece of shit."



# **Dot-Communication**

Never say something in plain English when you can bust out an obscure acronym or puzzling jargon. The technology bubble forged its own lexicon.



# Intranet teleconferencing

webcast Web conferencing webiner

# **Business Gobbledygook**

CBM (customer relationship management) data-mining

data-warehousing

DSS (decision support system) ECM (enterprise content management)

EDI (electronic data interchange) ERP (enterprise resource planning)

ETL (extract, trensform, and load) **OLAP** (online enalytical processing)

OLTP (online transaction processing) supply-chain management

VAN (value-added network)



# sticky Media

information broker

brick-and-mortal

click-and-morta

eyeballs

Impressions

marketspace

m-commerce

hits

portal vortal

walled garden

# Error: Pants on fire!



"We are the good guys. We are on the side of angels."



B2B (business to business)

B2C (business to consumer)

B2E (business to employee)

B2G (business to government) C2C (consumer to consumer)

G2B (government to business)

G2C (government to citizen)

Docume

G2G (government to gc Error: Irrational exuberance

P2P (peer to peer)

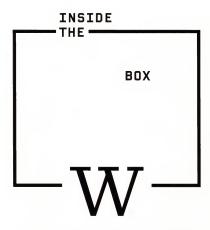




"Things will pick up again, because not even Alan Greenspan can stop the Internet economy."

-Larry Kudlow, CNBC host, February 2000 (Indeed, not even Greenspan could stop the Internet aconomy—from tanking.)





# WANT TO KNOW HOW GOOGLE IS ABOUT TO CHANGE

your life? Stop by the Ouagadougou conference room on a hursday morning. It is here, at the Mountain View, California, headquarters of the world's most powerful Internet company, that a room filled with three dozen engineers, product managers, and executives figure out how to make their search engine even smarter. This year, Google will introduce 650 or so improvements to its fabled algorithm, and each will be determined to the control of the control o

mined at a gathering just like this one. The decisions made at the weekly Search Quality Launch Meeting will wind up affecting the results you get when you use Google's search engine to look for anything. "Samsung SF-755p printer." "Ed Hardy MySpace layouts," or maybe even "capital Burkina Faso." which just happens to



share its name with this conference room. Udi Manber, Google's head of search since 2006, leads the proceedings. One by one, potential modifications are introduced, along with the results of months of testing in various countries and multiple languages. Ascreen displays side-by-side results of sample queries before and after the change. Following one example—a search for

"guitar center wah-wah"-Manber cries out, "I did that search!"

You might think that after a solid decade of search-market dominance, Google could relax. After all, it holds a commanding 65 percent market share and is still the only company whose name is synonymous with the verb search. But just as Google isn't ready to rest on its laurels, its competitors aren't ready to concede defeat. For years, the Silicon Valley monolith has used its mysterious, seemingly omniscient algorithm to, as its mission statement puts it, "organize the world's information." But over the past five years, a slew of companies have challenged Google's central premise; that a single search engine, through technological wizardry and constant refinement. can satisfy any possible query. Facebook launched an early attack with its implication that some people would rather get information from their friends than from an anonymous formula. Twitter's ability to parse its constant stream of updates introduced the concept of real-time search, a way of tapping into the latest chatter and conversation as it unfolds. Yelp helps people find restaurants, dry cleaners. and babysitters by crowdsourcing the ratings. None of these upstarts individually presents much of a threat, but together they hint at a wide-open, messier future of search—one that isn't dominated by a single engine but rather incorporates a grab bag of services.

Still, the biggest threat to Google can gla gar Joeg to set you for Still, the biggest threat to Google can be found 850 miles to the north: Bing. Microsoft's revamped and rebranded search engine—with a name that evokes disovery, a famous crooner, or Tony Soprano's strip joint—launched last June to surprisingly upbeat reviews. (The Wall Street Journal called it "more inviting than Google.") The new look, along with a \$100 million at campaign, helped boost Microsoft's share of the US search market from 8 percent to about 11—a number that will more than double once regulators approve a deal to make Bing the search provider for Yahoo.

Team Bing has been focusing on unique instances where Google's algorithms don't always satisfy. For example, while Google does a great job of searching the public Web, it doesn't have real-time access to the byzantine and constantly changing array of flight schedules and fares. So Microsoft purchased Farecast—a Web site that tracks airline fares over time and uses the data to predict when ticket prices will rise or fall—and incorporated its findings into Bing's results. Microsoft made similar acquisitions in the health, reference, and shopping sectors, areas where it felt Google's algorithm fell short.

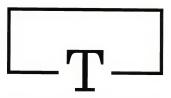
Even the Bingers confess that, when it comes to the simple task of taking a search term and returning relevant results, Google is still miles ahead. But they also think that if they can come up with a few areas where Bing excels, people will get used to tapping a different search engine for some kinds of queries. "The algorithm is extremely important in search, but it's not the only thing," says Brian MacDonald, Microsoft's Vp G

core search. "You buy a car for reasons beyond just the engine."

Google's response can be summed up in four words: mike siwek lawyer mi.

awyer m. Amit Singhal types that koaninto his company's search box. Singhal, a gentle man in his forties, is a Google Fellow, an honorific bestowed upon him four years ago to reward his rewrite of the search engine in 2001. He jabs the Enter key. In a time span best measured in a hummingbird's wing-flaps, a page of links appears. The top result connects to a listing for an attorney named Michael Siwek in Grand Rapids, Michigan. It's a fairly innocuous search—the kind that Google's servers handle billions of times a day—but it is deceptively complicated. Type those same words into Bing, for instance, and the first result is a page about the NFL draft that includes safety Lawyer Milloy. Several pages into the results, there's no direct referral to Sivek.

The comparison demonstrates the power, even intelligence, of Google's algorithm, honed over countless iterations. It possesses the seemingly magical ability to interpret searchers' requests—no matter how awkward or misspelled. Google refers to that ability as search quality, and for years the company has closely guarded the process by which it delivers such accurate results. But now I am sitting with Singhal in the search giant's Building 43, where the core search team works, because Google has offered to give me an unprecedented look at just how it attains search quality. The subtext is clear You may think the algorithm is little more than an engine, but wait until you get under the hood and see what this bay can really do.



THE STORY OF GOOGLE'S ALGORITHM BEGINS WITH PAGERANK, the system invented in 1997 by cofounder Larry Page while he was a grad student at Stanford. Page's now legendary insight was to rate pages based on the number and importance of links that pointed to them—to use the collective intelligence of the Web itself to determine which sites were most relevant. It was a simple and powerful concept, and—as Google quickly became the most successful search engine on the Web—Page and cofounder Sergey Brin.

credited PageRank as their company's fundamental innovation.

But that wasn't the whole story, "People hold on to PageRank because it's recognizable," Maniber says. "But there were many other things that improved the relevancy." These involve the exploitation of certain signals, contextual clues that help the search engine rank the millions of possible results to any query, ensuring that the most useful ones I float to the too.

Web search is a multipart process, First, Google crawls the Web to collect the contents of every accessible site. This data is broken down into an index (organized by word, just like the index of a textbook), a way of finding any page based on its content. Every time a user types a query, the index is combed for relevant pages, returning a list that commonly numbers in the hundreds of thousands, or millions, The trickiest part, though, is the ranking process-determining which of those pages belong at the top of the list.

That's where the contextual signals come in. All search engines incorporate them, but none has added as many or made use of them as skillfully as Google has. PageRank itself is a signal, an attribute of a Web page (in this case, its importance relative to the rest of the Web) that can be used to help determine relevance. Some of the signals now seem obvious. Early on, Google's algorithm gave special consideration to the title on a Web page—clearly an important signal for deter-

mining relevance. Another key technique exploited anchor text, the words that make up the actual hyperlink connecting one page to another. As a result, "when you did a search, the right page would come up, even if the page didn't include the actual words you were searching for," says Scott Hassan, an early Google architect who worked with Page and Brin at Stanford. "That was pretty cool." Later signals included attributes like freshness for certain que-

ries, pages created more recently may be more valuable than older ones) and location (Google knows the rough geographic coordinates of searchers and favors local results). The search engine currently uses more than 200 signals to help rank its results. Google's engineers have discovered that some of the most impor-

Google's engineers have discovered that some of the most important signals can come from Google itself. PageRank has been cele-

# KEY ADVANCES IN GOOGLE SEARCH

Google's search algorithm is a work in progress—constantly tweaked and refined to return higher-quality results. Here are some of the most significant additions and adaptations since the dawn of PageRank.—S.L.

BACKRUB (SEPTEMBER 1997)
This search engine, which had run on Stanford's servers for almost two years, is renamed Google. Its breakthrough innovation: ranking searches based on the number and quality of incoming links.

NEW ALGORITHM [RUGUST 2001] The search algorithm is completely revamped to incorporate additional ranking criteria more easily.

### LOCAL CONNECTIVITY ANALYSIS (FEBRURRY 2003)

Google's first patent is granted for this feature, which gives more weight to links from authoritative sites. FRITZ (SUMMER 2003)
This initiative allows Google to update its index constantly, instead of in big batches.

# PERSONALIZED RESULTS (JUNE 2005)

Users can choose to let Google mine their own search behavior to provide individualized results.

BIGDADDY (DECEMBER 2005)
Engine update allows for morecomprehensive Web crawling.

UNIVERSAL SEARCH (MRY 2007)
Building on Image Search, Google
News, and Book Search, the new
Universal Search allows users
to get links to any medium on the
same results page.

# REAL-TIME SEARCH

Displays results from Twitter and blogs as they are published.

brated as instituting a measure of populism into search engines: the democracy of millions of people deciding what to link to on the Web. But Singhal notes that the engineers in Building 43 are exploiting another democracy—the hundreds of millions who search on Google. The data people generate when they search—what results they click on, what words they replace in the query when they're unsatisfied, how their queries match with their physical locations—the properties of the p

turns out to be an invaluable resource in discovering new signals and improving the relivence of results. The most direct example of this process is what Google calls personalized search—an optin feature that uses someone's search history and location as signals to determine what kind of results they'll find useful. (This applies only to those who sign into Google before they search.) But more generally, Google has used its huge mass of collected data to bolster its algorithm with an amazingly deep knowledge base that helps interpret the complex intent of cryptic queries.

Take, for instance, the way Google's engine learns which words are synonyms. "We discovered a nifty hing very early on," Singhal says. "People change words in their queries. So someone would say, 'pictures of dogs,' and then they'd say, 'pictures of puppies.' So that told us that maybe 'dogs' and 'puppies' were interchangeable. We also learned that when you boil

water, it's hot water. We were relearning semantics from humans, and that was a great advance."

But there were obstacles. Google's synonym system understood that a dog was similar to a puppy and that boiling water was hot. But it also concluded that a hot dog was the same as a boiling puppy. The problem was fixed in hate 2002 by a breakthrough hased on philosopher Ludwig Wittgenstein's theories about how words are defined by context. As Google crawled and archived billions of documents and Web pages, it analyzed what words were close to each other. "Hot dog" would be found in searches that also contained "bread" and "mustard" and "baseball games"—not poeched pooches. That helped the algorithm understand what "hot dog"—and millions of other terms—meant.

"Today, if you type 'Gandhi bio,' we know that bio means biography," Singhal says. "And if you type 'bio warfare,' it means biological."

Throughout its history, Google has devised ways of adding more signals, all without disrupting its users' core experience. Every couple of years there's a major change in the system—sort of equivalent to a new version of Windows—that's a big deal in Mountain View but not discussed publicly. "Our job is to basically change the engines on a plane that is flying at 1,000 kilometers an hour, 30,000 feet above Earth," Singhal says. In 2001, to accommodate the rapid growth of the Web, Singhal essentially revised Page and Brin's original algorithm completely, enabling the system to incorporate new signals quickly. (One of the first signals on the new system distinguished between commercial and noncommercial pages, providing better results for searchers who want to shop.) That same year, an engineer named Krishna Bharat, figuring that links from recognized authorities should carry more weight, devised a powerful signal that confers extra credibility to references from experts' sites. (It would become Google's first patent.) The most

recent major change, codenamed Caffeine, revamped the entire indexing system to make it even easier for engineers to add signals.

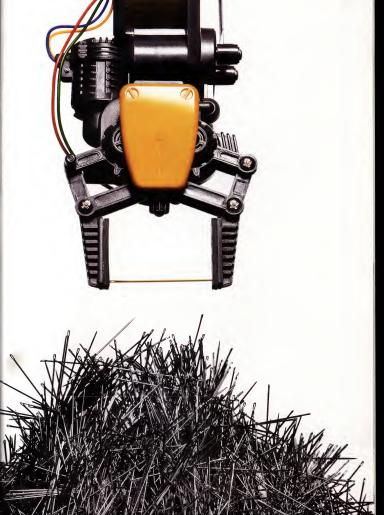
Google is famously creative at encouraging these break-throughs; every year, it holds an internal demo fair called CSI—Crazy Search Ideas—in an attempt to spark offbeat but productive approaches. But for the most part, the improvement process is a relentless slog, grinding through had results to determine what isn't working. One unsuccessful search became a legend: Sometime in 2001, Singhal learned of poor results when people typed the name "audrey fino" into the search box. Google kept returning Italian sites praising Audrey Hepburn. (Fino means fine in Italian.) "We realized that this is actually a person's name," Singhal says. "But we didn't have the smarts in the system."

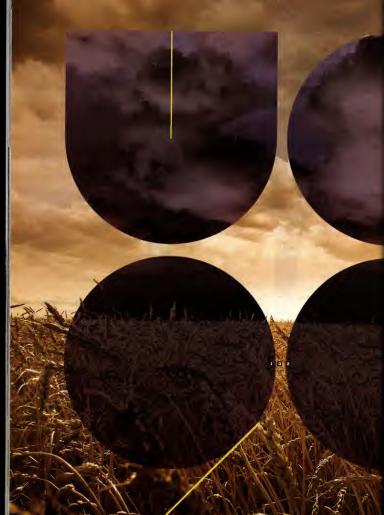
The Audrey Fino failure led Singhal on a multiyear quest to improve

The synonym system knew that a dog was similar to a puppy and that boiling water was hot. But it also thought a hot dog was a boiling puppy.

the way the system deals with names—which account for 8 percent of all searches. To crack it, he had to master the black art of "b'-jeram breakage"—that is, separating multiple words into discrete units. For instance, "newyork" represents two words that go together (a bi-gram). But so would the three words in "newyork times," which clearly indicate a different kind of search. And everything changes when the query is "new york times square." Humans can make these distinctions instantly, but Google does not have a Brazil-like back croom with hundreds of thousands of cubicle jockeys. It relies on algorithms.

The Mike Siwek query illustrates how Google accomplishes this. When Singhal types in a command to expose a layer of code underneath each search resul; if s clear which signals determine the selection of the top links: a bi-gram connection to figure it's a name; a synonym; a geographic location. "Deconstruct this query from an engineer's point of view," Singhal explains. "We say, 'Ahgl We can break this here! We figure that lawyer is not a last name and Siwek is not a middle name. And by the way, lawyer is not a town in Michigan. A lawyer is an attorney." I CONTINUE ON PAGE IT





ITS SPORES RIDE THE WIND, WIPING OUT WHEAT CROPS AND SPREADING FAMINE. IT HAS BREACHED THE BEST DEFENSES SCIENCE CAN OFFER. INSIDE THE RACE TO STOP THE UG99 FUNGUS-BEFORE PEOPLE BEGIN TO STARVE. BY BRENDAN I. KOERNER



the women of Njoro can't help but gawk at the odd scene across the road. In a wheat field ringed by barbed wire, a dozen men wearing white polyethylene jumpsuits stand in a tight huddle, eyes fixed on the green-and-amber stalks that graze their knees. They chat in foreign tongues—Urdu, Farsi, Chinese—that are rarely heard here amid the accia trees and donkey carts of Kenya's Rift Valley. The men's hazmat-style safety gear suggests they might be hunting down one of the infamous viruses that flourish in this part of the world—Ebola, perhaps, or Marburg.

Then the leader of the huddle, Harbans Bariana, a rotund Australian in an undersize safari hat, begins reading aloud from his clipboard: "Wylah?" he asks.

His colleagues bend down to examine some flaccid plants flecked with red splotches. A lanky Pakistani with a salt-and-pepper beard rakes a finger along one of the mottled stalks; an iodine-like residue rubs off on his skin. "40 S." he calls out.

The men move three steps right to a slightly more robust clump of wheat. The Australian asks: "Yandanooka?"

"25 MR?" comes the tentative reply from a mustachioed Nepali in a green baseball cap. They slide over to inspect another stalk, and then another.

To the women at the tap, faces scrunched in puzzlement, the call-and-response sounds like gibberish—and to most of the world, it is. But to the jump suited strangers in East Africa—a group of elite plant

pathologists-these codenames and numbers are a lingua frança, describing just how badly a crop has been ravaged by disease. These specialists have come to Nioro on this autumn afternoon to study a scourge that is destroying acres of Kenyan fields. The enemy is Ug99, a fungus that causes stem rust, a calamitous disease of wheat. Its spores alight on a wheat leaf, then work their way into the flesh of the plant and hijack its metabolism. siphoning off nutrients that would otherwise fatten the grains. The pathogen makes its presence known to humans through crimson pustules on the plant's stems and leaves. When those pustules burst, millions of spores flare out in search of fresh hosts. The ravaged plant then withers and dies. its grains shriveled into useless pebbles.

Stem rust is the polio of agriculture, a plague that was brought under control nearly half a century ago as part of the celebrated Green Revolution. After years of trial and error, scientists managed to breed wheat that contained genes capable of repelling the assaults of Puccinia graminis, the

formal name of the fungus.

But now it's clear: The triumph didn't last. While languishing in the Ugandan highlands,

a small population of P. graminis evolved the means to overcome mankind's most ingenious genetic defenses. This distinct new race of P. graminis, dubbed Ug99 after its country of origin (Uganda) and year of christening (1999), is storming east, working its way through Africa and the Middle East and threatening India and China. More than a billion lives are at stake, "It's an absolute game-changer," says Brian Steffenson, a cereal-disease expert at the University of Minnesota who travels to Nioro regularly to observe the enemy in the wild.

"The pathogen takes out pretty much everything we have." Indeed, 90 percent of the

world's wheat has little or no protection against the Ug99 race of P. graminis. If nothing is done to slow the pathogen, famines could soon become the norm-from the Red Sea to the Mongolian steppe-as Ug99 annihilates a crop that provides a third of our calories. China and India, the world's biggest wheat consumers, will once again face the threat of mass starvation, especially among their rural poor. The situation will be particularly grim in Pakistan and Afghanistan, two nations that rely heavily on wheat for sustenance and are in no position to bear added woe. Their fragile governments may not be able to survive the onslaught of Ug99 and its attendant turmoil.

After the pustules burst

the plant withers and dies.

The pathogen has already been detected in Iran and may now be headed for South Asia's most important breadbasket, the Puniab. which nourishes hundreds of millions of Indians and Pakistanis. What's more, Ug99 could easily make the transoceanic leap to the United States. All it would take is for a single spore, barely bigger than a red blood cell, to latch onto the shirt of an oblivious traveler. The toll from that would be ruinous; the US Department of Agriculture estimates that more than 40 million acres of wheat would be at serious risk if Ug99 came to these shores, where the grain is the third most valuable crop, trailing only corn and soybeans. The economic loss might easily exceed \$10 billion; a simple loaf of bread could become a luxury. "If this stuff gets into the Western Hemisphere," Steffenson says, "God help us."

He and his fellow scientists around the world are scrambling to halt the pathogen. To do so, they must figure out a way to reach deep within the wheat genome and create genetic barriers that Ug99 cannot overcome. And they must do so quickly, before the pestilence moves on to the next continent, and then the one after that-wreaking havoc on the world's food supply.

WILLIAM WAGOIRE LOVES WHEAT. "WHEAT IS WHAT MADE ME WHAT I am," he says as he strolls through the Njoro plot of grain. For Wagoire, an agricultural researcher from neighboring Uganda, this field is a sort of heaven. It is where the world's top wheat breeders send thousands of their most promising plants, genetically souped-up varieties with an array of curious nicknames: Babax, Kingbird, Pastor, Khvaki, Circus, Milan. The breeders hope that one of these wheats will someday prove to be the One—the variety capable of withstanding Ug99. Every few yards, Wagoire passes a white sign staked neatly into the ground, indicating a row's country of origin: Iraq, Iran, Afghanistan, Pakistan, Nepal, Australia.

Wagoire, 55, was once a wheat breeder of some renown, having studied at the University of Cambridge and apprenticed under the late Norman Borlaug, a Nobel-laureate agronomist who revolutionized modern farming. But even though he hasn't worked full-time on wheat for years, Wagoire will forever have a place in cereal lore as the man who discovered the Ug99 race of P. graminis.

Wagoire earned that distinction several millennia after mankind's first run-in with stem rust. Wheat fragments bearing traces of P. graminis have been found at a Bronze Age archaeological site in Israel. And the Romans worshipped a minor god named Robigus, who had the power to stave off rust. Every April 25, as part of

> a festival called Robigalia, they would curry favor with the deity by sacrificing red-haired dogs.

P. graminis proved to be a prolific killer throughout the ensuing centuries, regularly tormenting both Old World and New. Certain death by starvation awaited European peasants whose crops were struck, while Mesoamerican Indians learned to fear the plague they called chahuistle. And the first English settlers in Massachusetts were aghast when rust wiped out their cereal crops in the 17th century, almost causing them to starve. In the US, stem rust was the bane of the Great Plains, which endured frequent epidemics throughout the 19th and early 20th centuries. One of the most disastrous episodes occurred in the middle of World War I, when

was once the bane of the Great Plains. causing frequent crop failures. P. graminis obliterated 200 million bushels of wheat-

Stem rust

one-third of the nation's annual consumption. Countless Midwestern families scrambled to survive on nutrient-poor corn mush. "There is and has been for the last six months very wide and extended suffering upon the part of the poor people of this country for want of food," and fada os enator declared in the spring of 1917, as her crisis reached its peak. Soon after, the spooked federal government ordered the eradication of barberry, the plant upon which P. gramin's rests and reproduces when wheat is scarce. The epidemies abated, but they didn't stop: A two-year outbreak in the mid-1950s, for example, caused \$3 billion worth of damage to the Great Plains' crops.

In the early 1940s, after the onset of World War II made it impossible to conduct philanthropic works in either Europe or China, the Rockefeller Foundation turned it statention to Mexico, where destitute campesinos suffered from chronic malnutrition. The foundation dispatched 30-year-old agroomsist Norman Borlaug to Mexico in 1944 to lead a project aimed at ending the nation's hunger. When Borlaug first arrived south of the border, Mexico was reeling from a three-year bout with stem rust, which had cut wheat production in half. Borlaug resolved to breed a variety of wheat that P. graminis could not kill. Thus began the Green Revolution, the lifesaving agricultural movement that would earn him the Nobel Peace Prize in 1970.

There was no high tech trick to Borlaug's work, just countless hours of experimentation that he would later describe as "mind-warpingly tedious." The lows native collected cereals from around the world, bred them with one another, and then took copious notes on the physical characteristics of the resulting crosses that frace well in Mexico's fields. After many years of selecting and refining the top performers, he identified several genes capable of frustrating P. grammins. The most impressive was dubbed Stem Rust 31, or Sr31, a gene that several of Borlaug's colleagues had bred into wheat from a rye chromosom.

Not only did 5x3l successfully fend off the pathogen, it also vastly improved grain yields. Farmers clambered to plant wheat that bore 5x3l, which quickly became the world's predominant rust-prevention gene. Developing nations in particular adopted the seeds, which they obtained from Borlaug's International Maize and Wheat Improvement Center, or Cimmyt (pronounced "SIMi-t").

The creation of rust-resistant wheat was one of the cornerstone achievements of Borlaug's Green Revolution, which produced

multiple disease-proof, high-yielding crops capable of feeding once-hungry populations. By 1970, stem rust was no longer a threat to nations that relied on wheat as a dietary mainstay. It is impossible to calculate how many lives Sr31 and other disease-resistance genes saved, but hundreds of millions would be a fair guess. Finally able to feed their burgeoning populations, developing countries like India were able to grow and prosper beyond all expectations. Two generations of farmers and agronomists came of age never having witnessed a stem-rust infection in the wild, and P. graminis largely ceased to be of interest to anyone except Cold Warriors: The US and Soviet militaries spent years trying to weaponize the pathogen. (America developed a cluster bomb containing turkey feathers smeared with spores; the stockpile was eventually destroyed

after President Nixon renounced the use of offensive bioweapons.)

Cereal-disease expert Brian Steffenson inspects Ug99-infested wheat,

Stem rust thus beaten back, Wagoire was understandably amazed when he inspected the
open-air fields at Uganda's Kalengyere Highland Crop
Research Centre in November 1998. As one of Borlaugs's
many disciples, Wagoire had spent part of 1998 at Cinmyx
headquarters in Mexico, breeding wheat designed to
resist yellow rust, a comparatively mild disease cause
by the Puccinia striiformis fungus. When he returned to
southwest Uganda, he planted his lines on a hillside at
Kalengyere, where yellow rust ran rampant. But while
conducting a routine check of his maturing plants, Wagorder received a nasty surprise. Instead of being dusted
with the jaundiced streaks indicative of yellow rust, the
crop was pocked with scaly crimson pustules: stem rust.

Wagoire thought he had been careful to breed wheat that carried the Sr31 gene, but now he wasn't so sure. Had the Ugandan veteran somehow made a rookie mistake?

He fired off an anxious email to Ravi Singh, chief wheat breeder at Cimmyt. "I said, 'Look,' think maybe I selected the wrong materials. All this stuff, it has all fallen down from stem rust,' "he recalls. Singh wasn't buying it. There was just no way a breeder as accom-

#### VIRULENT PESTS HAVE ATTACKED OUR CROPS BEFORE



### Potato (1845-1849)

(Phytophthora infestans)
IMPACT The pathogen obliterates Ireland's mainstay
crop, leading to a million
famine-related deaths and
mass emigration.
RESPONSE It takes 36 years,

mass emigration.

RESPONSE It takes 36 years,
but scientists develop a moldkilling chemical mixture.



#### Grape (1860-1900)

DISEASE Grape phylloxera (Daktulosphaira vitifoliae) IMPACT Bugs infest a third of France's grapes and ravage the vineyards in Germany and Italy.

RESPONSE French vines are grafted onto aphid-resistant root stock from the US, saving the European wine industry.



#### Corn (1970)

DISEASE Southern corn leaf blight (Helminthosporium maydis) IMPACT Some 710 million bushels of corn are lost after a

mutated fungus rips through stalks from lowa to Maine. RESPONSE Imported seeds and rigorous crop screening quell the outbreak.



#### Cassava (1989-1997)

DISEASE Cassava mosaic

IMPACT The virus decimates Uganda's cassava crop, which provides up to half the caloric intake in the war-torn country.

RESPONSE By 1992, plant geneticists succeed in breeding a disease-resistant variety.





the formerly

invincible

Sr31 gene.

plished as Wagoire had failed to breed Sr31 into his lines. The likelier scenario was that the Ugandan had mistakenly written "stem rust" when he meant "stripe rust" (a synonym for yellow rust).

But a second pass through the Kalengyere fields only confirmed that the pustules were the unmistakable handi-work of P. gramfinis. Wagoire realized there was just one logical conclusion: A new race of the stem-rust pathogen had somehow evolved undetected in a secluded region of Uganda, and it was capable of defeating the formerly invincible 5-37 gene.

Still, Cimmyt wanted a second opinion before sounding the alarm that Sr-31 had been breached. The organization contacted Zak Pretorius, a plant pathologist at the Univer-

sity of the Free State in Bloemfontein, South Africa, and asked him to analyze a live sample of the pathogen. Pretorius agreed, even though doing so would place him in legal jeopardy—importing P. graminis spores into South Africa was strictly forbidden. "It was wrong for me to receive the samples." he admis: "but I decided to test them anwaw."

To get the illicit sample to Pretorius in early 1999, Wagoire used a method that in retrospect seems slightly reckless: He clipped a few infected stalks, sealed them in a plain white envelope, and dropped it off for DHL delivery.

Most of the spores died en route to Bloemfontein, but Pretorius was able to scrape together just enough to carry out his veri-

NOW If COULD

Resily

OVERWhelm

Now if could by the sprayed the surviving spores on several strains where quickly plastered with red—P. graminis had evolved, and it could now overcome Sr31 with astonishing ease.

Iteratives tabled these surped on the story. Kam-

Uganda's tabloid press jumped on the story. Kampala newspapers manipulated the facts to demonize Wagoire, making it appear as though he had somehow synthesized Ug99 in a lab. Accustomed to hearing tales of how Western scientists had invented HIV, the Ugandan public was all too willing to swallow the sci-fi narrative. "The local politicains and the general populace, they do not know about the evolution of diseases," Wagoire says. "All they know is that research scientists work in laboratories and that diseases are in

laboratories. So in this case, the story was 'Wagoire has created a disease which is going to vipe out all the wheat in the world!' That was a very trying time for me.' Uganda's government shuttered its wheat research program soon after, and Wagoire moved on to an administrative post. (Wagoire maintains that the program was dropped purely for economic reasons.)

Beyond Uganda's borders, however, the discovery was mostly greeted with a collective shrug. "We do not anticipate that the newly discovered virulence to Sr31 poses an important threat to wheat production in the US," the USDA announced in April 1999, pointing out that several other effective resistance genes—notably Sr4. and M36—were present in much of the nation's wheat. Besides, the pathogen had been detected only in an isolated corner of Uganda, near the Rwandan border. The odds of its spreading to neighboring countries, to say nothing of beyond East Africa, seemed slim.

But those who dismissed Ug99 as a mere anomaly would soon be proven dreadfully wrong.

A QUARTER MILE FROM THE STATE FAIRGROUNDS IN ST. PAUL, WHERE
1.8 million Minnesotans gather each summer to inhale corn dogs
and ride the Zipper, there's a one-story brick structure that could
easily be mistaken for a post office. But no dead letters are

stored within this building's vault—only live pathogens.
This is the USDA's Greal Disease Laboratory, where 30,000 enemies of wheat, barley, and oats are held captive so their malevolent secrets can be learned. And among these pathogens are numerous samples of Ug99, sent here from nations already infiltrated by the new strain of P. gramins.

The CDL is one of only two labs in the world legally permitted to analyze live P. graminis spores imported from abroad. The critical work of dealing with live cultures takes place for three months each year, December through February. Should any particles of P. graminis escape, the theory goes, they will find no wheat in Minnesota's frozen fields to infect and will thus perish before causing any lasting damage. (The other lab that handles live stem-rust spores is in similar to the property of the property

larly frigid Winnipeg, Manitoba, for precisely the same reason.) After the winter session, the CDL puts its Ug99 in suspended animation, so the pathogen can be reanalyzed for years to come. For the other P. graminis samples, many of which date back to the 1950s, this is done by placing vials of spores together in vats filled with liquid nitrogen. But Ug99 is accorded special treatment: its spores are sealed in a dedicated frezer set to -112 degrees Fahrenheit. Solitary confinement is necessary to prevent a careless researcher from unleashing the enemy. "We wouldn't want someone to mistakenly grab the wrong tube out of the liquid nitrogen," says Les Szabo. a research exercise at the CDL as a research exercise at

A gangly man with a calm yet serious demeanor, Szabo is the world's leading *P. graminis* guru, having dedicated 22 years to studying what makes the pathogen tick. Prior to the emergence of Ug99, when stem rust was considered a relic, Szabo labored in obscurity—to specialize in *P. graminis* in the latter part of the 20th century was akin to being a Sovietologist after the fall of the Berlin Wall. But Szaboh sas suddenly found his esoteric expertise much in demand, turning him into something of an ag-science rock star.

Szabo Oddn't grow up with farming in his blood. He was raised in the Scattle area, when his father was a Boeing engineer, his mother a biochemist. But for reasons he can't quite pinpoint, Szabo has always been fascinated by the ways in which parasites bend hosts to their will. In 1988, when the USDA posted a seemingly undesirable job studying P. graminis, Szabo leapt at the opportunity to work in what he cheerfully terms "the backwater of science."

"One of the cool things about rust is its really intricate development process," says Zabo, who comes alive when describing Paraminis' craftiness. "It doesn't use the slash- and-burn approach, where you just kill tissue and live off that. It establishes itself and coexists with the host, then causes its damage. That balance, that ability to take over but coexist—it's a lot more sneaks." The fungus is also an efficient traveler: A single hectare of infected wheat releases upwards of 10 billion spores, any one of which can cause the epidemic to spread. The circumstances have to be just right, though—the prevailing winds must blow toward an area of wheat cultivation, and the P. graminis spores must survive the airbornejourney.

That is precisely what happened in the case of Ug99. Two years after its initial discovery at Kalengyere, the pathogen drifted into the fields of central Kenya, where it caused major losses and wreaked havoc on thousands of subsistence farms. The pathogen's next stop was Ethiopia, sub-Saharan Africa's biggest wheat producer, followed by eastern Sudan. (So far, those two countries have escaped major damage thanks largely to dry weather, which tends to hinder P. graminis.) By 2006, the pathogen had hopped over the Red Sea into Vennea, a disturbing migratory milestone. "Ilo oka 4 Yenen as the gateway into the Middle East, into Asia," says David Hodson, former chief of Cimmyt's Geographic Information Systems unit and now with the Food and Agriculture Organization in Rome, where he tracks global whear trusts.

In 2005, Hodson was asked to develop a model for predicting the spread of Ug99 based on global wind patterns. The climactic data he gathered suggested that airborne particles from Yemen would inevitably alight in Iran or Iraq. And sure enough, in 2007 and then in 2009 Iran endured successive Ug99 infections, suggesting that a full-blown epidemic is possible.

This spread to the Islamic Republic tracks neatly with what Hodson terms "Route A," the likeliest scenario for Ug99's migration. If his model continues to hold, the pathogen should steadily move toward the Puniah over

the next few years—almost an exact repeat of the migratory path taken by a novel form of yellow rust, which was first detected in Kenya in 1986, then arrived in India a decade later.

But Hodson is suspicious of just how predictable Ug99 has been so far. "Maybe one of the most surprising things for me is that we haven't yet seen a random jump, a very longdistance jump," he says. In rare instances, fungal spores have been known to ride the winds across oceans—a sugarcane rust that first appeared in Florida in 1978, for example, is thought to have blown in from Cameroon. Hodson's greater fear is that Ug99 will spread via the "747 route"-hitching rides on human travelers. This is how yellow rust first got to Australia in 1979, tucked into the clothing of a farmer who had vacationed in the French countryside.

Ug99 isn't just on the march. It's mutating, too: It has devel-

#### DEADLY MIGRATION

Since it was discovered a dozen years ago, Ug99 has steadily crept north and east out of Uganda. Wind patterns could soon carry it to the Punjab region on the border of India and Pakistan-one of Asia's most crucial breadbaskets, in the next few years, the pathogen could also travel through iran to Afghanistan, as well as into Turkey. -B.I.K.

oped the ability to overcome resistance genes that were being used to combat it. At least four variants of the pathogen have been discovered to date, and each has the ability to knock out resistance genes once thought to be worthy substitutes for 5x31. The most troubling of these variants, first detected in Kenya in 2006, tears through 5x34, the gene that so many North American wheat producers rely on to keep. P. graminis at bay. Another variant shreds 5x36, commonly used in the winter wheats of the Great Plains.

That's why the USDA has suddenly become so alarmed over Ug99 and why Szabo now finds himself a very busy (and well-funded) scientist. Armed with banks of high-speed polymerase chain reaction

machines, he's in the midst of a two-year project to sequence the Ug99 genome. He hopes to identify the pathogen's effector genes—the genes that actually do the dirty work of destroying wheat. If these genes can be cloned and inserted into bacteria that will produce the corresponding proteins, then new breeds of wheat could be screened for Ug99 resistance in a lab, eliminating the need to ship them to Nipro for exposure in the wild.

The CDL is especially busy during the winter months, when Szabo can devote time to his shipments of live *P. graminis*. He gets first crack at the foreign spores, so he can comb through their genetic material in search of microsatellites. These are stretches of DNA in which a reference *P. graminis* genome is known to contain a very simple sequence—say, 18 consecutive pairs of a cytosine (C) following the sequence—say, 18 consecutive pairs of a cytosine (C) following the sequence—say.

Scientists are combing the world for genes that could offer wheat

crops some

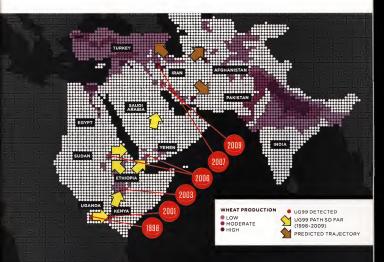
protection.

lowed by an adenine (A). But "slippage" tends to creep into such repetitive strands when new races like Ug99 evolve—an extra repeat might plop down in the middle of the CACACA monotony. That error becomes a DNA fingerprint for the race.

Using the microsatellite method, Szabo needs only 48 hours to determine whether a P. gramin's sample is Ug99. But given what's at stake for US wheat, he wants to ensure that precious days aren't wasted in sending samples to and from St. Paul. So he's developing a 24-hour DNA test called a TaqMan PCR, which can be used by regional pathology labs that regularly analyze infected wheat. The faster a Ug99 linvasion can be detected, the better the odds of containing

its damage: Fungicides can be applied immediately. (However, due to their expense, scarcity, and negative environmental impact, such fungicides are considered only a stopgap measure.)

But Szabo wants to do more than just play post-invasion defense. He also dreams of using his genomic intel to figure out elegant new ways of countering Ug99. When a P. graminis spore lands on a leaf, for example, it shoots out a germ tube that searches for a stomata—a portal into the plant's innards. The spore maximizes its chances of finding such an aperture by somehow sensing the topography of the leaf, then launching its probe perpendicular to the long axis of the surface cell. What if there were a way to give wheat a gene capable of scrambling the spores' topographical sense, so they could never burrow inside?



Szabo is a font of such ambitious, sometimes half-formed ideas for turning the tide against Ug99: He also has vague notions of transplanting resistance genes from rice, interrupting the pathogen's sugar intake, or using RNA to gunk up effector genes. But all of these strategies depend on learning more about what makes the fungus so aggressive in the first place. For now, the questions vastly outnumber the answers. "Having the genome is certainly going to give us some tools, but it's still going to take a long time to understand this organism," Szabo says. "It's much more than any one person can do in a careca.

BACK IN NJORO, BARIANA, THE CLIPBOARD-TOTING AUSTRALIAN geneticist from the University of Sydney, leans down to inspect Diamondbird, one of his heartiest specimens. He likes what he sees—stem rust has chewed up only a modest 20 percent of the surface area. Though there are a few red dots on the plant's stem, the pustules don't look too angry, like blisters about to possible straight of the surface area.

There is no single gene that has helped Diamondbird escape the worst of Ug99's punishment. The plant is protected instead by a combination of so-called minor genes, which work in tandem to slow the enemy rather than stop it cold. This pragmatic approach to engineering resistance is now much in vogue among breeders keen to make P graminis irrelevant once more.

The Green Revolution defeated stem rust by relying on single "major" genes like 573 and 5724, which bestowed near-blanket immunity to P. graminis. "But the thing about major genes is that they either work or they don't—it's black or white," Baritht they either work or they don't—it's black or white," Baritht they either work or they don't—it's black or white," Baritht they either work or they don't—it's black or white," Baritht they either work or they don't—it's black or white," Baritht they either work or they don't have been supported by the statement of the

ana says. So once Ug99 started beating the majors, the vast majority of the world's wheat immediately lost protection and became completely vulnerable.

Having been burned by this all-or-nothing strategy, breeders are now borrowing an idea from cryptography: They're trying to stack up minor genes that offer only partial resistance. By itself, a single minor gene does scant good-it can only slow down Ug99 so the pathogen is able to destroy just, say, 85 percent of a plant before harvest, instead of the customary 100 percent. But if five or six such genes can be crammed into a variety pack, the cumulative effect should be akin to that of a major gene. "It's a bit like adding one more number in the lottery," says Ronnie Coffman, international professor of plant breeding at Cornell University. The addition of each semi-resistance gene makes it exponentially tougher for the fungus to win out. This piecemeal approach may not be as sexy as discovering the next Sr31, but it's by far the most promising approach to ending the crisis.

Breeders are scouring the globe in search of useful minor genes, combing locations from Central Asia's grasslands to dusty museum storerooms. Bariana, for example, is sifting through the vintage collection of A. E. Watkins, a University of Cambridge breeder who gathered wild wheat varieties from the far corners of the British Empire during the 1930s.

When a minor-gene plant like Diamondibird proves to be a "slow ruster" in Njoro, the next step is to analyze its DNA. This is done to find markers linked to genes that control resistance. If such markers can be identified, breeding becomes an order of magnitude easier. Seedlings can be screened in the lab to make sure they carry the desired gene combo and only the best candidates sent to Kenya. As a result, Bariana estimates that minor-gene wheats possessing near-immunity to Ug99could beready for widespread planting in three to four years.

Yet innovation can do only so much. The other half of the equa-

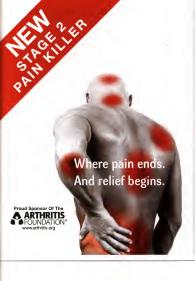
tion is politics-and PR: persuading tens of millions of farmers to switch to new wheats, especially in nations that have yet to suffer Ug99's wrath. Minor-gene wheats must therefore offer something more than just stem-rust resistance. They must also produce better grain and more of it than their predecessors, the Sr31 and Sr24 wheats that farmers have happily relied upon for decades. Therein lies a problem for breeders: Fiddling with one portion of a genome tends to have unpredictable effects on another. And the more slowrusting genes that are brought into a plant's genome, the tougher it can be to control unrelated traits like yield, height, and color. As the breeders keep tinkering, South Asia is bracing for impact. The CDL recently tried to get its hands on a suspicious P. graminis sample from Pakistan that is said to knock out Sr31. But the country is reluctant to share: "Some countries regard isolates of their pathogens as part of their genetic heritage," CDL director Marty Carson says. "I guess there's a fear that we'll patent something off of it." Preliminary analysis of dead spores indicates that the pathogen is not directly related to Ug99, but a Canadian lab is now in the process of doing a proper race analysis.

Meanwhile, for every Diamondbird there are a dozen setbacks. One autumn afternoon in Njoro, Steffenson, the cereal-disease expert from the University of Minnesota, strolled through the test field, checking on barley that was grown from seed he'd developed in his St. Paul greenhouse. It was a dispiriting affair. "Boy, these are getting spanked," Steffenson muttered as he passed by row after row of plants pocked by red pustules. "Blasted, just blasted." The victims included a variety whose genetic resilience he had prematurely extolled in a journal article just weeks before.

But there's no time to mourn these losses. Across the field from Steffenson, Bariana was busy evaluating hundreds of plants downwind of Diamondbird. His routine never varied: Bend at the waist, inspect the stalk, jot down the score on his clipboard. Few plants were faring well; Ug99 was having its way with the bluk of Bariana's creations. But the Australian kept at his tedious task for hours, until the sun began to set behind the acacla trees. He and his colleagues will do this again and again and again, until one of them finds the genetic hurdle that the enemy cannot clear.

Contributing editor BRENDAN I. KOERNER (Brendan\_Koerner @wired.com) wrote about smart grids in issue 17.04.







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Lab Mouse

mice with lung cancer and mice with breast cancer. Almost every university had cages full of them. Scientists tried to cure them. And whenever there was a run of good luck, the treatments would be tried on people.

These were the animals I grew up with. As a kindergartner, I would sit in my father's laboratory watching the day's doomed playmates crawl up and down my arms. Until the turned over the work to a young colleague, my father was the principal investigator of a multifecade project to discover and test epilepsy treatments. His laboratory at the University of Utah uses tens of thousands of mice every year. I recently took advantage of my family pass and dropped in for a look. There was one type of creat-

ture in particular I wanted to see. In March 1953, six weeks before James Watson and Francis Crick published their paper revealing the molecular structure of DNA, two relatively obscure zoologists, Hubert and Mable Frings, gave Science a short account of an inter-

esting discovery. The couple had

bred an epileptic mouse. Such achievements were commonplace among mousers. But the Prings mouse was distinguished by several unique qualities: the consistency of its seizures; the quick onset of those seizures, which allowed researchers to run through a battery of tests much faster than ever before; the fact that the mice usually lived through their attacks; and, most important, the weirdly simple way their convulsions could be triggered.

Steve White, the director of the university's Anticonvulsant Drug Development program, stands next to me with a set of keys. Tall and bearded, he speaks with a wry tone that suggests many years spent trying to solve a hard problem. Research on

epilepsy drugs has been going on in this lab for some four decades. Almost every medication currently prescribed for seizures has gotten its start here.

This show potential treatments are tested: First you find mice that have predictiveles esizures. Then you give some of them your drug. You count how many have seizures, how long it takes for them to begin, and how long they last. If the drugged mice do better than the nondrugged ones and the medication isn't too toxic, you can conduct additional animal trials. If those are successful, you have a plausible candidate for a clinical trial. Many treatments discovered this way fail to work well on humans. But all of those that do work have passed through this samulet.

White drops a lively mouse into a clear plastic cylinder. Holding his keys over the open container, he shakes them vigorously, circling the rim and making a constant jamiging sound. After a few seconds, the animal begins to run frantically around the bottom of the enclosure. Then suddenly it stops, rears up on its hind legs, and topples over, stretched out full length, rigid. The Frings mouse gets seizures in response to sound. "If you pick it up by its hind legs," asys my father, who has come along, "you

the mouse genome was coming unsealed. By 2001, researchers had sequenced most of the mouse genome, and a doctoral student named Shana Skradski was just completing several years of dogged crossbreeding and genomic analysis. She pinned the origin of the seizures in the Frings mouse to a single mutation that interfered with the production of a previously unknown protein. The discovery won Skradski a cover article in the journal Neuron. It also turned out to be the first step in picking up the genetic thread that tied the Frings mouse to humans. Later research showed that the seizures in the Frings mouse were related to a hearing impairment and that similar mutations in the human version of this gene also caused hearing loss. In humans, the condition is called Usher syndrome type II.

As an undergraduate, C. C. Little had dreamed of being able to untravel the precise relationship between an observed trait and its hidden hereditary cause. Now Stradski was using modern molecular genetics to fulfill Little's vision. Critics had long used the failure of mouse models to argue that mice and humans simply didn't have enough in common to extrapolate experimental results. In one sense, the level of

# THE MOUSE RUNS FRANTICALLY, THEN STOPS AND TOPPLES OVER—RIGID. "IF YOU PICK IT UP, YOU CAN HOLD IT OUT STRAIGHT, LIKE A PIECE OF WOOD."

can hold it out straight, like a piece of wood."
Despite the widespread use of this creature in seizure research, for a long time there
was no evidence that the cause of its attacks
resembled the cause of those in human
nations. The Erings mouse was circulate.

patients. The Frings mouse was simply a biological machine for producing seizures. It was an experimental instrument. Its physiology was what mattered, not its code. The genetic cause of the sound-induced seizures would remain unknown for decades.

But the story of the Frings mouse, like all of mousedom, underwent a dramatic change nine years ago. With the advent of rapid gene sequencing and easily accessible sequence libraries, the black box of the genome, mice resemble us closely. Nearly every human gene is also found in mice. In a case like Usher syndrome type II, where we can show that both mouse and human have similar mutations that interfere with the synthesis of a similar protein, leading to common symptoms, we can justly claim to have discovered the cause of the disease.

But there's a catch. To understand it, consider one of the most common human disorders linked to the mutation of a single gene: cystic fibrosis, one of the first human aliments to yield the secret of its origin to gene-sequencing techniques. In 1989, Francis Collins and 14 collaborators sequenced the mailtunctioning gene responsible for cystic

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fibrosis, which can cause severe lung disease. (It was a career-making achievement; today Collins is director of the National Institutes of Health.) There had never been a mouse model for cystic fibrosis, because nobody had ever observed a mouse with the disease. You can't fix a trait through inbreeding if that trait never shows up in the first place. But the same year that Collins and his colleagues found the gene, scientists devised a technique for "turning off" specific genes, which they used to create so-called knockout mice. They no longer had to wait for a mouse to show up with a desired trait. Researchers quickly engineered a strain of mice that had the same defect in the cystic fibrosis gene that humans had.

Unfortunately, those mice did not develop lung disease. The path from genes to traits was more complex than anybody had realized. It took years to get a mouse with a cystic-fibrosis-like lung ailment, and when this mouse finally appeared, it didn't have a mutattoin in the same gene that causes the disease in humans. Instead of giving us confidence that we could precisely control the genome, the genomic revolution did the opposite: It showed us how complex the genome was and how little of it we had mastered. "The good news is

we're getting very close to having the ability to affordably analyze the genomes of individual peeple," says Jacqueline Crawley, author of What's Wrong With My Mouse? Behavioral Phenotyping of Transgenic and Knockout Mice, a standard reference for researchers using mouse models to study neurodegenerative disorders like Alzheimer's disease. "But the bad news is that the genome is only part of the story. There are all kinds of modifiers of gene expression that will turn a gene on or off."

Even in rare cases, like that of the Prings mouse and Usher syndrome type II, where there is a close match between mice and humans, the way the mutation plays out in real life is highly complex. While both the humans and the mice have hearing loss, for instance, only the mice get epileps, "We still don't know what the missing protein does," White says. "Maybe it affects the auditory derive. Maybe it affects the auditory cortex. The more you know, the less you know."

Though social sugenics was discredited long ago, we still often think of the genome in quasi-sugenic terms. When we read about the latest discovery of a link between a gene and a disease, we imagine that we've learned the cause of the disease, and we may even think we'll get a cure by fixing the gene. In other words, we conceive of the genome as a standard code: At times it may harbor dangerous mutations, but it is perfectible.

This is wrong. Our experience in fooling around with the genes of mice has taught us that many of the traits that interest us are not definite products of specific mutations but emergent phenomena arising from extremely complex interactions between genes, environment, and life experience. Most of the cures for the medical problems that torment us will probably come not from fixing particular genes but from using the genome as a window into our biology. The tools of molecular genetics allow us to discover the role of enzymes, cells, neural circuits, even entire organs; it is these higher-level systems that may offer more reliable ways to jar our system from one emergent state into another we like better. Genes are switches that we can

are about 70,000 boxes of animals here.

The rearing rooms and shipping docks at Jackson are designed and maintained with safety in mind—even the mouse chow and wood shavings for bedding are sterilized before use. But they are not the ideal place to guard a valuable mouse colony against the vicissitudes of existence. The ideal place for that is in a vat of liquid nitrogen at -320.8 degrees Fahrenheit. Jackson has more than 3.5 million en myros preserved this way in one room, with plenty of space to spare. The embryos are thand and bred as needle. Some of the oldest, frozen 30 years ago, have been successfully warmed back to life.

Vast storage capacity is necessary because the new version of the laboratory mouse is especially interesting en masse. Originally, the point of making inbred mice was to observe the effect of precise genetic changes—often involving a single gene—on a nown background. Obese mice could be assumed to carry an obesty gene; diabetic mice, a diabetic gene. But this was far too simple. "All mice in the wild are small and brown," says Gary Churchill, at all, soft-spoken biostatistician with blue eyes and silvery brown hair. "Why? Oaks" Brown

# THE LAB HAS MORE THAN 3.3 MILLION FROZEN MOUSE EMBRYOS. SOME, PRESERVED 30 YEARS AGO, HAVE BEEN SUCCESSFULLY WARMED BACKTO LIFE.

toggle experimentally to learn how the rest of the system responds. That is, we can toggle them in mice.

That process starts here, at Jackson Laboratory, located on Mt. Desert Island off the coast of Maine. On a January day, the campus has the feel of an Arctic station. In the nearby resort rown of Bar Harbor, most of the storefronts are closed. Snow is drifting in the parking lots and packed down hard in the streets. At the large shipping dock attached to Jackson's mouse-breeding facility, trucks pull tight against weather-sealed bays. Inside the building, each room has hundreds of cages stacked in rows to the ceiling and ventilated by filtered air; all told there

mice, of course, are more difficult for predators like owls to see. "There is lots of genetic variability." Churchill says, "because there are also lots of different ways of being small and brown."

The same goes for being obese or having cancer. The outcome may look similar, but there are countiess ways to get there. Churchill deals with the complexity by using statistical methods to track the influence of multiple genes at once, but the traditional inbred mouse is of limited use for a project like this. Every animal in a standard mouse strain is genetically the same individual, and the difference between strains can amount to just a handful of genes. So

Churchill and some colleagues from other labs are going back and starting again, making new mice from eight strains. They are mixing them in many combinations. By the end of 2013, Churchill and his partners hope to have as many as 500 strains, giving them the capacity to create a quarter million mouse crossbreeds.

Statistical studies of the type Churchill is planning for his new mice are common tools of medical research; they have been used to zero in on genetic factors contributing to everything from smoking to infidelity. But doing gene association studies in a population of mice offers a key advantage: You can experiment on the mice, "With humans, you can't even do the simplest things, like organize matings," Churchill says. "With mice, once you know the mutation, you can do experiments to see how it works. You can knock out the gene, you can enhance its function, you can insert it into a different mouse to see how it works in another genetic context."

With the insights gleaned from such experiments, you can then go back to the lab and develop new tests and even thera-

pies. Mice with their immune systems turned off can be reprogrammed with genetic code for human immune function to test treatments for diseases like AIDS. Human intestines are being grown inside mice to look at the progression of Crohn's disease. Mice whose neurons have been altered through new "optogenetic" techniques to be sensitive to flashes of light are hooked up to computers, giving scientists millisecond-scale control of their neural circuitry. Genetically engineered mice can even be engrafted with cancerous tissue removed directly from a human patient to test the effectiveness of a treatment on the exact tumor it is meant to combat. (With a mouse designed to host your own tumor, you could try out a course of chemotherapy on a disposable part of yourself.) In all these cases, the mouse genome is not merely a code to be deciphered, a mammalian Rosetta stone that allows us to read and eventually rewrite our own genetic programming. Instead, it is a living laboratory where scientists can tinker with all that goes on between gene and trait.

The new lab mouse is no longer really a miniature human; it is a kind of genomic

explorer that allows us to move back and forth between life and code. We don't know which new techniques of mouse science we will ultimately apply to ourselves. Maybe all of them. Many mouse-tested methods have already made the leap to us: Therapies involving recoding portions of the human genome are in clinical trials; prosthetic devices attached to the human nervous system, such as cochlear implants, pave the way for prosthetics attached to the brain through an optogenetic interface; genotyping humans to determine disease susceptibility is offering us the chance to customize drug dosages for various human "strains," as if we were scientists experimenting on a mouse whose genetic tendencies were well known.

Part genomic archive, part cross-species host, and part cyborg, today's mouse is no longer merely a mammal. It is no longer really a mouse. That's OK. In the future it's leading us to, we are no longer merely humans.

Contributing editor GARY WOLF (gary@aether.com) interviewed PayPal cofounder Peter Thiel for issue 18.02.

#### COLOPHON

Resolutions that helped get this issue out: Spend less time on Facebook; do the splits; ride a motorcycle at 200 mph; stop hogging the health kits in Left 4 Dead 2; keep 5 am dates with the treadmill; keep this Tamagotchi alive for one more year; wear more bow ties; never spell it "Syfy"; soak in every hot spring in the world; catch up on the most recent chapters of Trapped in the Closet; 858 x 600 SVGA pocket projectors at CES; cull all pretentious art films from Netflix queue; make good on that whole "I'm starting yoga" thing; "The Situation" and Ronnie talking it out on Jersey Shore: After Hours; see Yosemite ... not from a speeding car; get more sleep; watch entire weekly TiVo list by Sunday night each week; no more late fees; consume lean proteins, healthy fats, and unprocessed carbs; have a child every year for the next 10 years; have more fun; stay off Jay's daily top 10 list; resolved: set five measurable goals for the year.

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Inside Google Search

This is the hard-won realization from inside the Google search engine, culled from the data generated by billions of searches: a rock is a rock. It's also a stone, and it could be a boulder. Spell it "roke" and it's still a rock. But put "fittle" in front off it and it's the capital of Arkansas. Which is not an ark. Unless Noah is around. "The holy grail of search is to understand what the user wants," Singhal says. "Then you are not untarching words; you are actually trying to match meaning."

And Google keeps improving. Recently, search engineer Maureen Heymans discovered a problem with "Cindy Louise Greenslade." The algorithm figured out that it should look for a person-in this case a psychologist in Garden Grove, California-but it failed to place Greenslade's homepage in the top 10 results. Heymans found that, in essence, Google had downgraded the relevance of her homepage because Greenslade used only her middle initial, not her full middle name as in the query. "We needed to be smarter than that," Heymans says. So she added a signal that looks for middle initials. Now Greenslade's homepage is the fifth result.

At any moment, dozens of these changes are going through a well-oiled testing process. Google employs hundreds of people around the world to sit at their home computer and judge results for various gueries. marking whether the tweaks return better or worse results than before. But Google also has a larger army of testers—its billions of users, virtually all of whom are unwittingly participating in its constant quality experiments. Every time engineers want to test a tweak, they run the new algorithm on a tiny percentage of random users, letting the rest of the site's searchers serve as a massive control group. There are so many changes to measure that Google has discarded the

traditional scientific nostrum that only one experiment should be conducted at a time. "On most Google queries, you're actually in multiple control or experimental groups simultaneously," says search quality engineer Patrick Riley. Then he corrects himself. "Essentially" he says, "all the queries are involved in some test." In other words, just about every time you search on Google, you're a lab mt.

This flexibility-the ability to add signals, tweak the underlying code, and instantly test the results-is why Googlers say they can withstand any competition from Bing or Twitter or Facebook. Indeed, in the last six months Google has made more than 200 improvements, some of which seem to mimic-even outdo-the offerings of its competitors. (Google says this is just a coincidence and points out that it has been adding features routinely for years.) One is real-time search, eagerly awaited since Page opined some months ago that Google should be scanning the entire Web every second. When someone queries a subject of current interest, among the 10 blue links Google now puts a "latest results" box: a Google's massive computing power and bandwidth give the company an undeniable edge. Some observers say it's an advantage that essentially prohibits startups from trying to compete. But Manber says it's not infrastructure alone that makes Google the leader: "The very, very, very key ingredient in all of this is that we hired the right people."

By all standards, of Lu qualifies as one of those people. "Thave the highest regard for him," says Manber, who worked with the 48-year-old computer scientist at Ayhoo. But Lu joined Microsoft early last year to lead the Bing team. When asked about his mission, Lu, a diminutive man dressed injeans and a Bing Tshrit, pauses, then softly recites a measured reply: "It's extremely important to keep in midatt this is a long-term journey." He has the same I'm-not-going-away look in his eye that Uma Thurman has in Kill Bill. Indeed, the company that won last decade's

eye that Uma Thurman has in Kill Bill.
Indeed, the company that won last decade's
browser war has a best-served-cold approach
to search, an eerie certainty that at some
point, people are going to want more than
what Google's algorithm can provide. "If we

#### "THE HOLY GRAIL OF SEARCH IS TO UNDERSTAND WHAT THE USER WANTS. THEN YOU'RE NOT MATCHING WORDS; YOU'RE MATCHING MEANING."

scrolling set of just-produced posts from news sources, blogs, or tweets. Once again, Google uses signals to ensure that only the most relevant tweets find their way into the real-time stream. "We look at what's retweeted, how many people follow the person, and whether the tweet is organic or a bot," Singhalsays." We know how to do this, because we've been doing it for a decade."

Along with real-time search, Google has introduced other new features, including a service called Goggles, which treats images captured by users' phones as search queries. It's all part of the company's relentless march toward search becoming an always-on, ubiquitous presence. With a camera and voice recognition, a smartphone becomes eyes and ears. If the right signals are found, anything can be query fodder. don't have a paradigm shift, it's going to be very, very difficult to compete with the current winners," says Harry Shum, Microsoft's head of core search development. "But our view is that there will be a paradigm shift."

Still, even if there is such a shift, Google's algorithms will probably be able to incorporate that, too. That's why Google is such a fearsome competitor; it has built a machine nimble enough to absorb almost any approach that threatens it—all while returning high-quality results that its competitors can't match. Anyone can come up with a new way to buy plane tickets. But only Google knows how to find Mike Siwek. We

Senior writer STEVEN LEVY (steven \_levy@wired.com) wrote about Twitter in issue 17.11.

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